

DRAFT
GREAT LAKES BINATIONAL TOXICS STRATEGY
DRAFT MANAGEMENT ASSESSMENT
FOR
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&

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EXECUTIVE SUMMARY

INTRODUCTION

The Great Lakes Binational Toxics Strategy identifies specific challenge goals for each Level 1 substance for the U.S. and Canada, with a timeframe that expires in 2006. As 2006 approaches, an analysis of progress and determination of next steps is needed to respond to the mandate set forth in the Strategy. A *General Framework to Assess Management of GLBTS Level 1 Substances* was developed to provide a tool to assist the Parties (Environment Canada and US EPA) and stakeholders in conducting a transparent process to determine the appropriate management outcomes for the Level 1 substances. This report presents an analysis of hexachlorobenzene (HCB) conducted using the general framework.

CHALLENGE GOAL STATUS

Both Canada and the US have achieved significant reductions of HCB from sources resulting from human activity. While this satisfies the US commitment, Canada continues to pursue the goal of a 90 percent reduction in HCB releases. Estimated releases of HCB in the US have been reduced from approximately 8,519 lbs (3,872 kg) in 1990 to 2,911 lbs (1,323 kg) in 1999. Differences in the methods of estimating emissions for the 1990 and 1999 inventories, however, complicate the determination of the total overall percentage reduction. In Ontario, releases of HCB have been estimated at 44 lbs (20 kg) in 2003, reduced by approximately 62 percent, relative to a 1988 baseline. It is unlikely that Canada's 90 percent reduction goal will be met by 2006.

ENVIRONMENTAL ANALYSIS

There are sufficient data on the environmental presence of HCB in multiple media to assess the impact of HCB in the Basin. Assessment of the environmental data for HCB has shown declining concentrations in various media (herring gull eggs, water, sediment, air), an absence of fish advisories in the Great Lakes, and HCB levels below detection in fish tissue and human serum in broad national surveys. However, individual research studies have found measurable levels of HCB in tissue samples of residents in the Great Lakes region, including blood and breast milk. A few current exceedances of sediment and water quality criteria are observed. Continued HCB releases and intercontinental transport may explain the longer-than-expected half-lives for HCB observed in air over the Great Lakes.

SOURCES OF HCB

In addition to HCB releases from sources in the U.S. and Canada, long-range transport and deposition of HCB from elsewhere around the world can contribute to loadings in the Great Lakes. HCB is thought to be widely distributed in the global atmosphere with global emissions estimated at 50,600 lbs (23,000 kg). However, the contribution of global HCB concentrations to the Great Lakes is uncertain. Sources in Ontario were estimated to release 44 lbs (20 kg) in 2003, and releases from sources in the U.S. were estimated at 2,911 lbs (1,323 kg) in 1999. Principal sources of HCB in the U.S. and Ontario are pesticide application (volatilization of HCB as a microcontaminant), residential household waste burning (burn barrels), the manufacture of chemicals and plastics materials, and the use of ferric/ferrous chloride containing trace levels of HCB.

OPPORTUNITY ASSESSMENT

A number of opportunities for the GLBTS HCB Workgroup remain. The HCB Workgroup is working to refine HCB emissions estimates for pesticide application, chemical manufacturing, combustion sources, and publicly owned treatment works. The HCB Workgroup continues to encourage emission reductions from pesticide application and chemical manufacturing. The HCB Workgroup also supports other actions which impact HCB releases, including: (i) Household Garbage Burning Strategy in the Great Lakes Basin (GLBTS Burn Barrel Subgroup); (ii) Full lifecycle management of PCP-treated wood products; and (iii) Collection of data on HCB levels in the environment.

MANAGEMENT OUTCOME

HCB releases from identified sources have been reduced in Ontario and the U.S. HCB levels in the Great Lakes continue to decline in all measured media. Levels of the pollutant are not a lake-specific concern. Establishing new challenge goals for HCB, in either the U.S. or Canada, would provide no added benefit towards achieving further HCB reductions. The final management outcome for HCB is continued active Level 1 status with reassessment in 2008 by the GLBTS. The GLBTS HCB Workgroup will:

- 1) Resolve inventory discrepancies, particularly for pesticide application, chemical manufacturing and combustion sources, so that Basin and national progress in reducing HCB emissions can be tracked;
- 2) Identify the impact of long-range transport to the Great Lakes so that the contribution of US and Ontario sources can be determined;
- 3) Coordinate with international programs (e.g., Stockholm Convention, LRTAP) to manage HCB globally;
- 4) Obtain all possible HCB emission reductions in the US and Ontario, consistent with the Strategy's objective of virtual elimination;
- 5) Form an emission inventory subgroup, probably one subgroup for all Level 1 substances;
- 6) Establish sector subgroups for any major sector that remains a significant contributor;
- 7) Expand the HCB Workgroup to include chlorobenzenes; and
- 8) Determine the best way to coordinate with the GLBTS Dioxin Workgroup.

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ABBREVIATIONS

B(a)P	Benzo(a)pyrene
CCME	Canadian Council of Ministers of the Environment
CEC	Commission for Environmental Cooperation
CWS	Canada Wide Standards
DFO	Department of Fisheries and Oceans
EC	Environment Canada
HCB	Hexachlorobenzene
FDA	Food and Drug Administration
GLBTS	Great Lakes Binational Toxics Strategy
GLWQA	Great Lakes Water Quality Agreement
IADN	Integrated Atmospheric Deposition Network
IARC	International Agency for Research on Cancer
LBS	Pounds
LEL	Lowest Effect Level
LRTAP	Long-Range Transboundary Air Pollution
MDEQ	Michigan Department of Environmental Quality
NAPS	National Air Pollution Surveillance Network
NEI	National Emissions Inventory
NEL	No Effect Level
NHANES	National Health and Nutrition Examination Survey
NLFA	National Listing of Fish Advisories
NPRI	National Pollutant Release Inventory (Canada)
NYSDEC	New York State Department of Environmental Conservation
OCS	Octachlorostyrene
OMOE	Ontario Ministry of the Environment
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PCP	Pentachlorophenol
POTWs	Publicly Owned Treatment Works
PTDI	Provisional Tolerable Daily Intake
SEL	Severe Effect Level
TRI	Toxics Release Inventory (United States)
TSMP	Toxic Substances Management Policy
US EPA	United States Environmental Protection Agency

DRAFT MANAGEMENT ASSESSMENT FOR HCB

1.0 INTRODUCTION

The Great Lakes Binational Toxics Strategy (GLBTS) identifies specific reduction challenges or goals for each Level 1 substance for the U.S. and Canada. The time frame for achieving the Strategy's challenge goals expires in 2006. As 2006 approaches, an analysis of progress and determination of next steps is needed to respond to the mandate set forth in the Strategy. The *General Framework to Assess Management of GLBTS Level 1 Substances* was developed to provide a tool to assist the Parties, Environment Canada (EC) and the U.S. Environmental Protection Agency (US EPA), and stakeholders in conducting a transparent process to determine the appropriate management outcomes for the Level 1 substances: mercury, polychlorinated biphenyls (PCBs), dioxins and furans, hexachlorobenzene (HCB), benzo(a)pyrene (B(a)P), octachlorostyrene (OCS), alkyl-lead, and five cancelled pesticides: chlordane, aldrin/dieldrin, DDT, mirex, and toxaphene. The framework presents a logical flow diagram for evaluating progress and the need for further action by the GLBTS on the Level 1 substances. Further details on the background and objectives of the framework are provided in Appendix A.

This report discusses the analysis of hexachlorobenzene (HCB) using the *General Framework to Assess Management of GLBTS Level 1 Substances*. While the framework's flow diagram guides the discussion, the primary intent of the analysis is to present an overall evaluation of the status of the substance with respect to:

- Progress toward the GLBTS challenge goals;
- Levels in the Great Lakes environment; and
- Future management of the substance within the GLBTS.

HCB (CAS registry number 118-74-1) is a halogenated aromatic hydrocarbon that does not occur naturally. HCB was once used as a fungicide on grains, but the US EPA cancelled registered uses in 1984. Although there are no commercial uses of HCB in the U.S. or Canada, it is formed as a microcontaminant in various manufacturing processes, waste streams, and combustion operations. HCB is also found as a microcontaminant in several currently used pesticides, chlorinated solvents, and other chlorinated compounds. HCB continues to be produced and used in a few developing countries (ATSDR, 2002).

HCB is a persistent environmental toxin that bioaccumulates in fish, marine animals, birds, plants, and humans. HCB has been evaluated by the International Agency for Research on Cancer (IARC) and is considered possibly carcinogenic to humans (Group 2B classification; IARC, 2001). HCB is known to cause a range of adverse effects, including neurotoxicity and liver damage, to individuals exposed either directly or indirectly (e.g., through breast milk) (US EPA, 2005c).

2.0 CHALLENGE GOAL STATUS

Have the challenge goals for the substance been met?

The GLBTS challenge goals for the U.S. and Canada, as stated in the 1997 Great Lakes Binational Toxics Strategy agreement, are:

Canadian Challenge: Seek by 2000, a 90 percent reduction in releases of HCB from sources resulting from human activity in the Great Lakes Basin, consistent with the 1994 Canada-Ontario Agreement.

U.S. Challenge: Seek by 2006, reductions in releases, that are within, or have the potential to enter the Great Lakes Basin, of HCB from sources resulting from human activity. The Strategy also states that, in regard to the U.S. challenge for HCB, “Current information does not yet provide support for a more specific reduction challenge but as soon as data are available, a target will be included.”

Both Canada and the U.S. have achieved significant reductions of HCB from sources resulting from human activity. While this satisfies the U.S. commitment, Canada continues to pursue the goal of a 90 percent reduction in HCB releases. A description of the progress made by each country is provided below.

Ontario

In Ontario, releases of HCB have been reduced by approximately 62 percent, relative to a 1988 baseline. Figure 1 illustrates HCB releases in Ontario, by sector, for 1988 and 2003. Figure 2 illustrates the trend in HCB air releases reported to Canada’s National Pollutant Release Inventory (NPRI) by Ontario facilities from 2000 to 2003. The NPRI data show that HCB air releases from Ontario facilities decreased by 53 percent from 2000 to 2003 with the number of facilities reporting non-zero releases decreasing slightly from 29 in 2000 to 25 in 2003. The following sectors represent the majority of the emissions reductions achieved in Ontario:

- Pesticide application – Improvements in the manufacturing process
- Incineration – Closure of the City of Hamilton's Solid Waste Reduction Unit incinerator and implementation of Canada-wide Standards for the incineration of municipal solid waste, sewage sludge, and hazardous waste, and from closure of Ontario’s hospital waste incinerators
- Chemical manufacturing – Decommissioning of the chlorinated organics manufacturing facility at Dow Chemical Canada in Sarnia
- Sewage Treatment Plants – Majority of influent and sludge concentrations have decreased to non-detectable levels
- Wood Preservation – Implementation of Technical Recommendations Document for the Design and Operation of Wood Preservation Facilities at wood treating facilities using pentachlorophenol (PCP)

Further incremental reductions in HCB emissions are anticipated, but it is unlikely that Canada's 90 percent reduction goal will be met by 2006. Total HCB releases in Ontario were estimated at 44 lbs (20 kg) per year in 2003. Achieving the challenge goal would require a further reduction of 33 lbs (15 kg) per year, or total annual HCB releases of 11 lbs (5 kg) per year.

Several barriers limit reductions of HCB emissions in Ontario. The majority of HCB releases (75 percent) are from non-point sources such as pesticide application (volatilization of HCB as a microcontaminant), open burning, and the use of ferric/ferrous chloride containing trace levels of HCB. Obtaining reductions from such sources is difficult. The remaining HCB releases are from sectors where reductions will be driven by other contaminants and/or priority programs. These include sources such as cement production and iron and steel manufacturing.

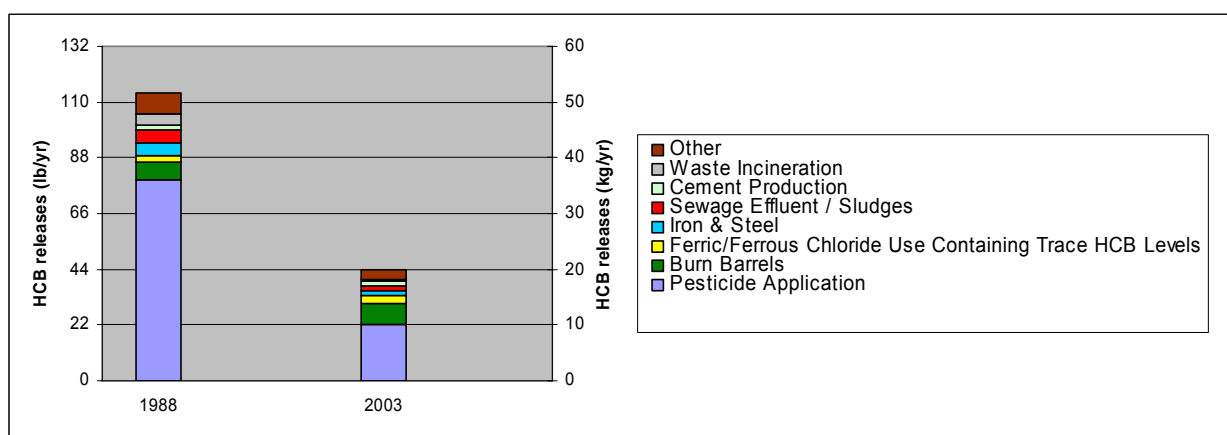
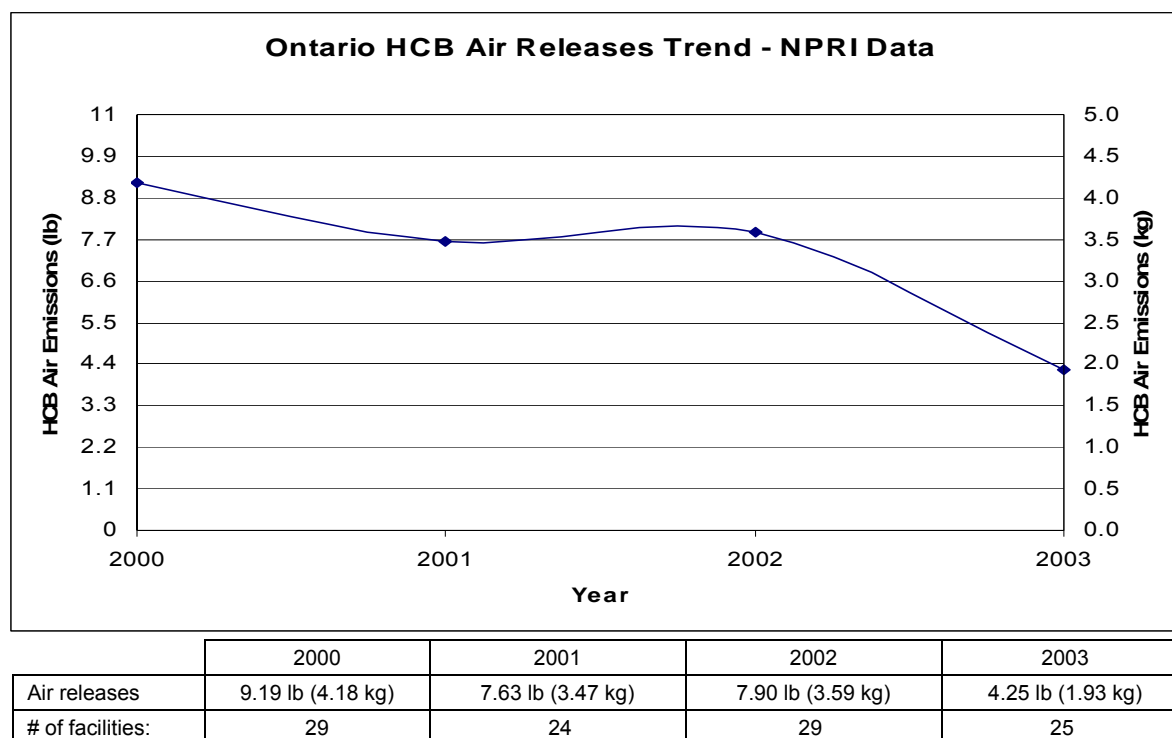


Figure 1. Estimated HCB Releases (to Air and Water) in Ontario by Sector, 1988 and 2003. Source: Environment Canada (Environmental Protection Branch - Ontario Region, Toxics Prevention Division) Inventory as of October 13, 2004, with an update on releases from pesticide application received from Health Canada's Pest Management Regulatory Agency (Letter dated April 11, 2005)



Notes:

1. In 2003, HCB releases reported to NPRI from Ontario facilities account for only 10% of total Ontario HCB releases.
2. NPRI data show that HCB releases from Ontario facilities decreased by 53% from 2000 to 2003.
3. SWARU (Solid Waste Reduction Unit) Municipal Solid Incinerator in Hamilton, Ontario, released 1.8 kg in 2002.
The shutdown of this facility in Dec. 2002 accounts for the majority of the HCB reduction.
4. Water releases were 0 in 2000, 0 in 2001, 0.0013 lb (0.0006 kg) in 2002, and 0.0013 lb (0.0006 kg) in 2003.
5. Chart based on NPRI information as of June 6, 2005.

Figure 2. Ontario HCB Air Releases Reported to NPRI (2000-2003)

Source: Environment Canada

United States

Because of the potential for HCB releases to be transported to the Great Lakes, the HCB Workgroup has focused on nationwide HCB releases in the U.S. Relative to a 1990 baseline, releases of HCB in the U.S. from the sources identified at that time have been reduced from approximately 8,519 lbs (3,872 kg) in 1990 to 2,911 lbs (1,323 kg) in 1999. Figure 3¹ presents national HCB release estimates for the U.S. and progress achieved since 1990. Most of this reduction is the result of lower levels of residual HCB in pesticides as well as from reduced emissions from chlorinated solvent production and pesticide manufacture. These three categories combined account for a reduction of approximately 5,000 lbs (2,273 kg) of HCB emissions.

Differences in the 1990 and the 1999 emission inventories and source categories complicate the determination of the exact emission reductions that have occurred. The 1990 and 1999

¹ Based on EPA's 1990 National Toxics Inventory (with 1999 open burning estimates added) and 1999 National Emissions Inventory (updated with 1999 pesticide application emissions data).

inventories represent the best inventory information that is available and provide a useful snapshot of HCB emissions from several source categories in 1990 and 1999. However, due to inconsistencies in the sources included in the two inventories, they cannot be used to establish a specific reduction in HCB emissions between 1990 and 1999.

Reductions of HCB releases in the U.S. are also apparent in the data reported to the Toxics Release Inventory (TRI). Figure 4 presents TRI releases of HCB to air and water from 1990 to 2003, the most recent year for which data are available. With the exception of one unusually large release in 1992, reported HCB releases to air declined by approximately 60 percent from 1990 to 1999. In 2000, the TRI reporting threshold was lowered from 100 lbs to 10 lbs to capture releases from facilities that were previously not required to report to TRI. As a result, the number of facilities reporting, as well as the quantity of HCB releases to air and water, increased from 1999 to 2000.

The change in reporting threshold beginning with year 2000 obscures the trends in HCB air and water releases reported to TRI. While HCB releases to water appear to have decreased from 1990 to 1999, water releases have remained over 100 pounds since 2000. HCB releases to air showed no apparent trend from 1994 to 1999, prior to the change in reporting threshold. Since 2000, HCB air releases have remained over 1,000 pounds.

The number of facilities reporting HCB releases to TRI has increased from 8 facilities in 1990 to 50 facilities in 2003. In 2002, the 8 facilities reporting HCB air and water releases in 1990 had reduced their HCB releases by 80 percent. The change in reporting threshold in 2000 caused a four-fold increase in the number of facilities reporting HCB releases to TRI.

The HCB Workgroup is attempting to verify HCB emissions resulting from the volatilization of HCB as a microcontaminant when pesticides are applied, as well as the potential for future reductions. The HCB Workgroup is also seeking to improve emission estimates for other sources of HCB, specifically combustion sources. These activities will provide better measurements of progress in reducing HCB emissions.

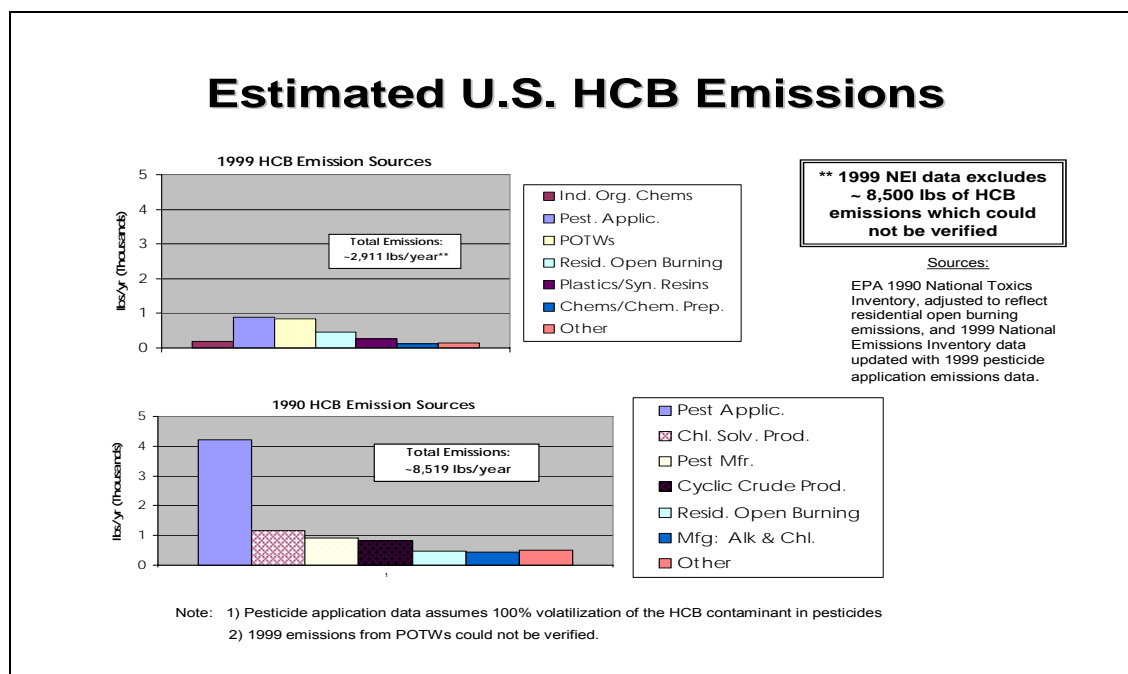


Figure 3. Estimated U.S. HCB Releases for 1990 and 1999 (lbs/year)
Source: US EPA

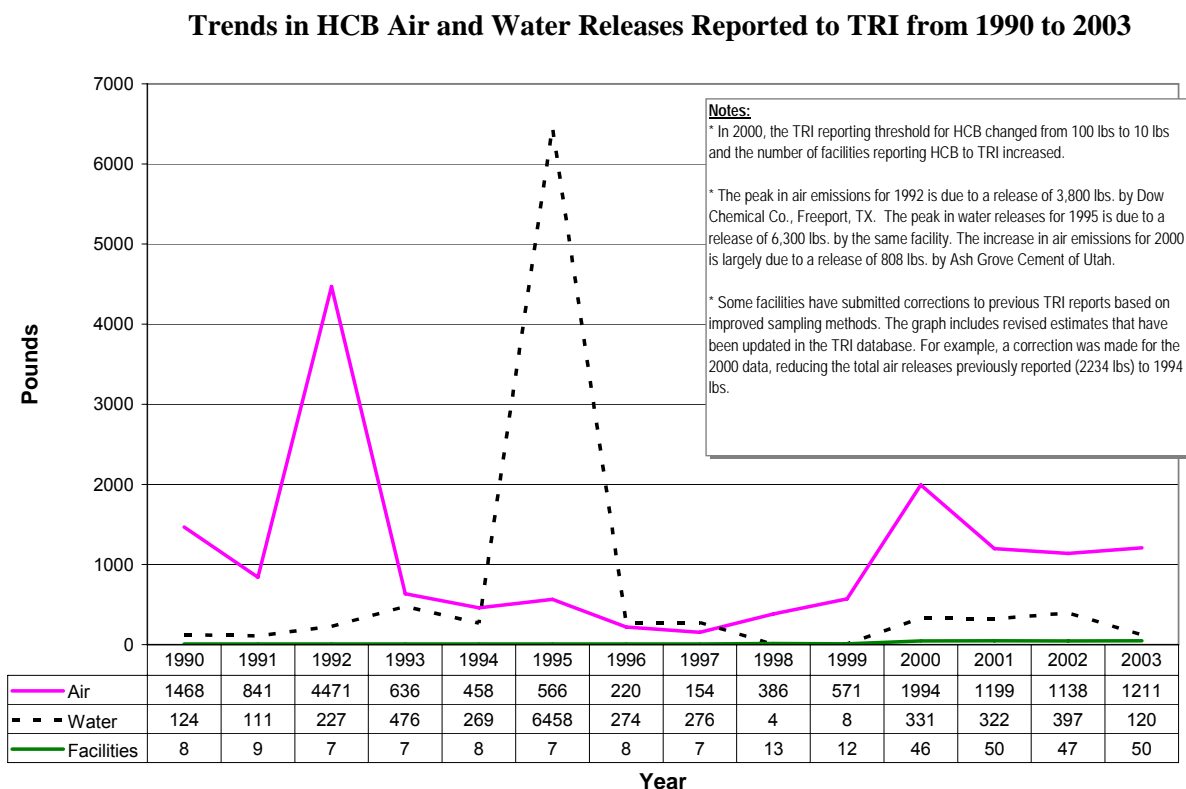


Figure 4. U.S. HCB Air and Water Releases Reported to TRI (1990-2003) (lbs/year)
Source: US EPA

3.0 ENVIRONMENTAL ANALYSIS

The *General Framework to Assess Management of GLBTS Level 1 Substances* calls for an analysis to consider Canadian and U.S. environmental monitoring data and established human health or ecological criteria as the primary basis for an objective evaluation of whether HCB imposes a negative impact on the Great Lakes Basin. In preparing this report, efforts were made to identify basin-specific measures in air, water, sediment, fish, wildlife, food, and human biological samples. In some cases, national data are presented.

3.1 ENVIRONMENTAL AND HUMAN HEALTH DATA

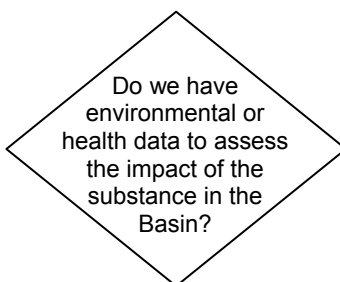


Table 1 presents environmental and human health data to assess the likely impact of HCB on the Great Lakes Basin. The table and ensuing discussion show that, **in general, there are sufficient data on the environmental presence of HCB** in multiple media to assess the impact of HCB in the Basin. Appendix C contains descriptions of additional monitoring programs that could not be included in the present report but would provide useful information for future assessments.

Table 1. Environmental and Human Health Data

DATA	RISK-BASED CRITERIA	EXCEEDANCES	TRENDS
Whole Fish			
Canadian Department of Fisheries and Oceans (DFO) Monitoring Program ¹	None	N/A	Declining trend to levels below detection (< 0.005 µg/g)
Fish Tissue			
National Listing of Fish Advisories	US EPA health endpoints for edible portion of fish: ² Carcinogenic 0.0018 mg/kg (wet wt) Noncarcinogenic 0.23 mg/kg (wet wt)	6 advisories in Ohio River Valley, issued in 1993	N/A
U.S. National Fish Tissue Study	See above	None: HCB not detected in first-year (1999-2000) & second-year (2001) samples	No trend data available

DATA	RISK-BASED CRITERIA	EXCEEDANCES	TRENDS
Biota			
Canadian Wildlife Service Herring Gull Egg Monitoring Program	None	N/A	Percent declines 82% to 98% across Great Lakes from 1974 to 2003
Niagara River Mussel Biomonitoring Program ³	None	N/A	Since 1980s, typically not detected at Canadian sites and at trace levels (< 10 ng/g wet wt) at U.S. sites
Sediment			
EC Water and Sediment Contaminant Monitoring Programs ⁴	PSQ LEL: 0.02 (µg/g dw); PSQ SEL: 24 (µg/g organic carbon) ⁵		Declines of 38% in Lake Ontario and 49% in Lake St. Clair (1997-2002)
- Fort Erie suspended sediment	None	N/A	Decline of 61% from 1987 to 2000
- Niagara-on-the-Lake suspended sediment	None	N/A	Decline of 51% from 1987 to 2000 Trend stable since 1995
- Wolfe Island suspended sediment	None	N/A	Decline of 87% from 1989 to 2000
- St Clair River	None	N/A	Decline of 80% at Port Lambton, 1987-1999
Tributary Sediments (Lower Lakes 2001-2003)	PSQ LEL: 0.02 (µg/g dw)	Criteria exceeded	Insufficient data to determine trends
12-Mile Creek/Old Welland Canal Sites (2003)	PSQ LEL: 0.02 (µg/g dw)	None	No trend data available
Open Water			
EC Water and Sediment Contaminant Monitoring Programs ⁴	US EPA guideline for water: ⁶ 0.28 ng/L MDEQ: ⁷ 0.45 ng/L		
- Fort Erie dissolved phase	NYSDEC: ⁸ 0.03 ng/L	None	Decline of 54% from 1987 to 2000
- Niagara-on-the-Lake dissolved phase	NYSDEC: ⁸ 0.03 ng/L	Yes, from 1987 to 1999	Decline of 60% from 1987 to 2000 Trend stable since 1995
- Wolfe Island dissolved phase	NYSDEC: ⁸ 0.03 ng/L	Yes, in 1989 and 1990	Decline of 76% from 1989 to 2000 Trend stable since 1995
- St Clair – Detroit River Corridor	NYSDEC: ⁸ 0.03 ng/L	Yes, 2001-2002	No trend data available
- St Clair River	NYSDEC: ⁸ 0.03 ng/L	Yes, 1987-1996 & 1999 at Port Lambton	Declining trend, 1987-1999
EC Great Lakes Water Quality Surveillance Program ⁹	NYSDEC: ⁸ 0.03 ng/L	Yes, 1986-1990 on Lakes Huron, Erie, and Ontario and Georgian Bay	Declining trends on Lakes Huron, Erie, and Ontario and Georgian Bay, 1986-2002. No trend on Lake Superior
Ambient Air			
Canadian National Air Pollution Surveillance (NAPS) Network	None	N/A	Declining trends from 1997 to 2002 at urban sites; Stable concs at rural sites

DATA	RISK-BASED CRITERIA	EXCEEDANCES	TRENDS
Integrated Atmospheric Deposition Network (IADN)	None	N/A	Declining trends on Great Lakes from 1992 to 2002 ¹⁰
Human Exposure			
U.S. National Health and Nutrition Examination Survey (NHANES)	None	N/A	No trend data available
Health Canada Exposure Assessment (1998) ¹¹	PTDI: 270 ng/kg bw/day	None	No trend data available
Food Supply			
Canadian Total Diet Study	PTDI: 270 ng/kg bw/day	None	No trend data available

¹ Whittle, 2005.² US EPA, 2000a.³ Richman, 2005.⁴ Programs include the St. Clair River Upstream/Downstream Monitoring Program, Niagara River Upstream/Downstream Monitoring Program, and St. Lawrence River Monitoring Program (US EPA, 2004a; Waltho, 2005).⁵ MOE, 1993.⁶ US EPA, 2002.⁷ MDEQ, 2003.⁸ NYSDEC, 1999.⁹ Whole water (1988-1990) or dissolved phase data (1994-2002) for Lakes Superior, Huron, Erie, and Ontario and Georgian Bay (Waltho, 2005).¹⁰ At U.S. sites in Great Lakes. Concentrations increased somewhat during the late 1990s, but overall, a declining trend for the period is observed.¹¹ Health Canada, 1998.

Abbreviations used in the table:

Bw – body weight

Dw – dry weight

EC – Environment Canada

LEL – Lowest Effect Level

MDEQ – Michigan Department of Environmental Quality

N/A – Not applicable

NYSDEC – New York State Department of Environmental Conservation

PSQ – Provincial Sediment Quality Guidelines

PTDI – Provisional Tolerable Daily Intake

SEL – Severe Effect Level

Wt – Weight

Canadian Department of Fisheries and Oceans (DFO) Monitoring Program

Long-term (>25 years), basinwide monitoring data measuring whole body concentrations of contaminants in top predator (lake trout and/or walleye) and forage fish (smelt) are collected by the Canadian Department of Fisheries and Oceans (DFO) to develop trend data on bioavailable toxic substances in the Great Lakes aquatic ecosystem. DFO reports contaminant burdens annually in similarly aged fish (4+ to 6+ range).

Conversations with DFO have confirmed, based on ongoing internal qualitative review of program data, these general observations (Whittle, 2005):

- Concentrations of HCB have shown a decline in the Great Lakes when considered from an overall perspective across all species and lakes. Maximum concentrations measured in lake trout collected in the late 1970s rarely exceeded 0.05 µg/g. It is estimated that 95 percent of current (2003) whole fish lake trout samples have HCB levels less than the detection limit of 0.005 µg/g.

- At this time, it appears that Basin point sources have a minimal impact on the overall trend in Great Lakes fish, and that out-of-Basin air deposition and environmental cycling are significant components of current trends.
- There are no GLWQA criteria for HCB to measure concentration exceedances in whole fish.

National Listing of Fish Advisories

The National Listing of Fish Advisories (NLFA) database, maintained by US EPA, includes all available information describing state-, tribal-, and federally-issued fish consumption advisories in the U.S. for the 50 states, the District of Columbia, and four U.S. territories, and in Canada for the 12 provinces and territories. The database contains information provided to US EPA by the states, tribes, territories, and Canada. The 2003 NLFA contains no fish consumption advisories for HCB in the Great Lakes (in either the U.S. or Ontario).

U.S. National Fish Tissue Study

The U.S. National Study of Chemical Residues in Lake Fish Tissue (or the National Fish Tissue Study) is a four-year national screening-level freshwater fish contamination study. The National Fish Tissue Study measures HCB in predator and bottom-dwelling fish tissue from lakes and reservoirs of the continental U.S. (excluding the Great Lakes). Analysis of the data for all four years of the study is not complete, but US EPA is releasing interim raw data for each year as it becomes available. A final report is expected to be completed in 2006.

Data are currently available for the first two years of the study. The first-year results consist of quality-assured raw data from analysis of fish samples collected from 143 lakes and reservoirs in the lower 48 states during fall 1999 through 2000 (US EPA, 2005b). HCB was not detected in first-year samples, which included locations at 45 sites in the Great Lakes states of New York, Pennsylvania, Ohio, Michigan, Illinois, and Minnesota (31 percent of first-year sites). The second-year results consist of quality-assured raw data from analysis of fish samples collected from 117 lakes and reservoirs in the lower 48 states during 2001. HCB was also not detected at sites sampled in the second year of the study. The method detection limit for HCB in the first- and second-year analyses was generally 111 µg/kg (US EPA, 2004b).

The data available for the first two years of the National Fish Tissue Study include over half of the approximately 500 lakes and reservoirs being sampled in the study. The Great Lakes were excluded from the lakes selected for the study, but lakes and reservoirs in the Great Lakes Basin were included. Levels of HCB below the limit of detection in the first two years of the study indicate that HCB levels in fish are not likely to represent a significant concern.

Canadian Wildlife Service Great Lakes Herring Gull Eggs

The Canadian Wildlife Service (CWS) has analyzed temporal trends in contaminant levels in herring gull eggs from fifteen colony sites on the Great Lakes. Eggs have been collected from up to eight water bodies within the Great Lakes Basin: the St. Lawrence, Niagara, and Detroit Rivers and Lakes Ontario, Erie, Huron, Michigan, and Superior. Concentrations of HCB were first analyzed in 1974. The consistent monitoring of herring gull eggs by the CWS provides high-quality data with sufficient geographic coverage to assess the ecological impact of HCB in the Great Lakes.

An analysis of data collected from the CWS Herring Gull Egg Monitoring Program through 2003 is presented in the Great Lakes Binational Toxics Strategy 2004 Draft Progress Report (US EPA, 2004a). Percent declines from 1974 to 2003 in HCB levels in herring gull eggs collected from Great Lakes waterbodies range from 82.1 percent to 97.5 percent. Figure 5 illustrates the trend in HCB levels in herring gull eggs at Port Colborne Lighthouse on Lake Erie from 1974 to 2003.

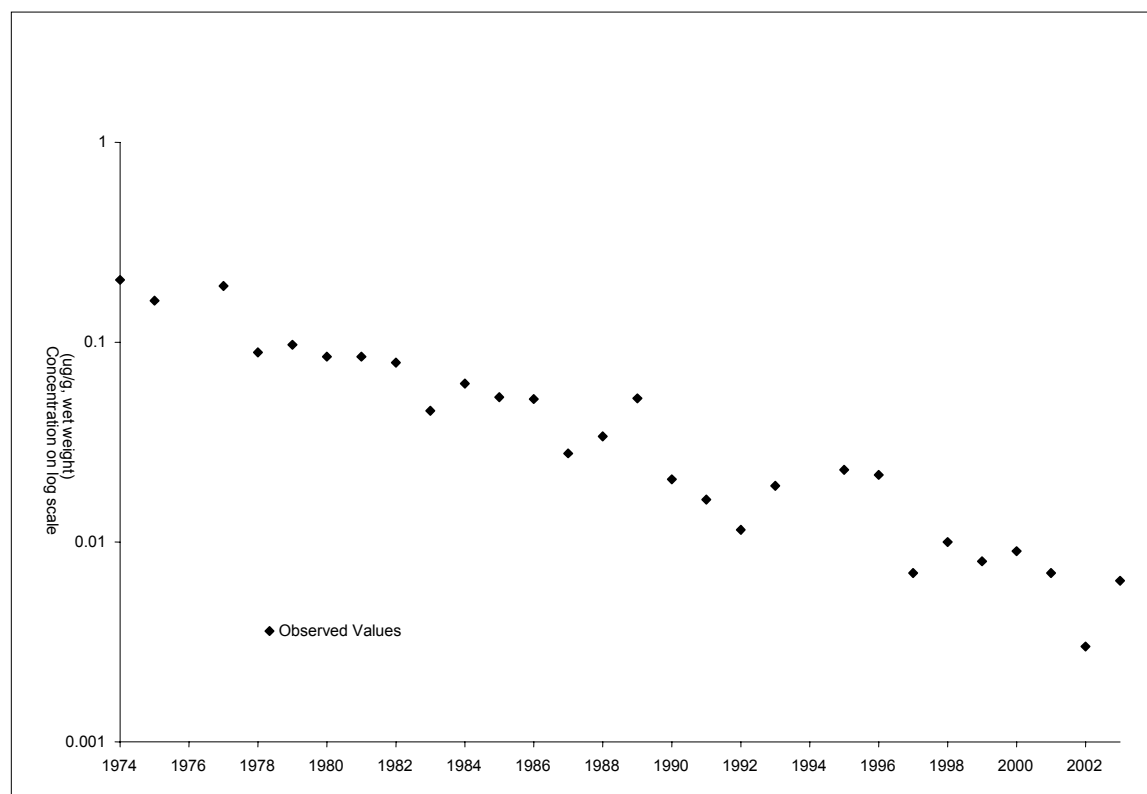


Figure 5. HCB in Herring Gull Eggs, Port Colborne Lighthouse, Lake Erie, 1974-2003.
Source: Canadian Wildlife Service

Niagara River Mussel Biomonitoring Program

The Ontario Ministry of Environment has conducted the Niagara River Mussel Biomonitoring program since 1980. Data generated by the program provide information on contaminants in the Niagara River between Fort Erie and Niagara-on-the-Lake. The mussel biomonitoring program

has provided information on suspected contaminant sources and source areas in the river and is part of an overall program to assess long-term trends in contaminant loadings from selected U.S. and Canadian sources along the Niagara River.

The Niagara River Mussel Biomonitoring program uses mussels as biomonitors. Biomonitors are an effective means of detecting bioaccumulative contaminants in the water when ambient concentrations are too low to be measured directly using conventional water sampling and analytical methods. The principle behind the mussel biomonitoring program is to take organisms from an uncontaminated site and place them in an environment that is known or suspected of being contaminated with persistent bioaccumulative substances. The biomonitors are left for a specified time to accumulate contaminants and are then analyzed to determine the contaminant concentrations in their tissue. By strategically placing the organisms upstream and downstream from a source, the presence or absence of contaminants in the water body can be determined. The detection of contaminants in the mussels indicates that the contaminants are bioavailable in the aquatic environment. The absence of a contaminant in mussel tissue is less definitive. It may suggest that the contaminant is not present or that it is not bioavailable in the surrounding environment. However, because of the site-specific nature of the biomonitor, it may also mean that the mussels were not placed near enough to the source to adequately detect the presence of contaminants.

Results of the Niagara River Mussel Biomonitoring program have shown that HCB is typically not detected in mussels deployed on the Canadian side of the river. This has been consistent since the 1980s with one exception where only trace concentrations were present in one mussel (1 ng/g).

HCB is usually one of the most frequently detected chlorinated compounds on the U.S. side of the river and is associated with specific sources. With the exception of known source areas (specific hazardous waste sites such as the 102nd Street Landfill, Hyde Park Landfill, and the Pettit Flume cove), HCB concentrations in mussels deployed along the river are typically at trace levels (i.e. < 10 ng/g wet wt.). However, variability within a station and between survey years requires that the data be interpreted with caution. Results of 2003 monitoring at the 102nd Street Landfill and Pettit Flume cove show that remediation efforts have been successful in removing the source of HCB contamination at these sites (Richman, 2005).

Environment Canada Water and Sediment Contaminant Monitoring Programs

Environment Canada began surface water monitoring in the open lakes and interconnecting channels in the late 1970s through the mid 1980s. Water and sediment contaminant monitoring programs are ongoing in the open waters and interconnecting channels of the Great Lakes. These programs include the *St. Clair – Detroit River Corridor Water Quality Monitoring Program*, *St. Clair River Upstream/Downstream Monitoring Program*, *Niagara River Upstream/Downstream Monitoring Program* and *St. Lawrence River Monitoring Program*, the *Great Lakes Water Quality Surveillance Program*, screening level surveys of sediment quality in Canadian tributaries to Lakes Erie and Ontario, and bottom sediment contaminant surveys conducted in the Great Lakes. Descriptions of the *St. Clair – Detroit River Corridor Water Quality Monitoring Program*, *Niagara River Upstream/Downstream Monitoring Program*, and the *St. Lawrence River Monitoring Program* are provided in Appendix B. Due to the ongoing and comprehensive nature of these programs, spatial and temporal trends reflecting the impact of

HCB on water quality can be assessed over the Great Lakes Basin. However, data with which to assess spatial and temporal trends that reflect the impact of HCB on sediment quality are limited.

The interconnecting channels programs in the St. Clair, Detroit, and Niagara Rivers provide information suggestive of local sources. The *St. Clair – Detroit River Corridor Water Quality Monitoring Program* includes one mid-channel upstream site and two downstream sites (one on the Canadian side and one on the U.S. side) in each river. This whole-water monitoring program, initiated by Environment Canada in 2001 for the St. Clair and Detroit Rivers, is a relatively new program and, as such, provides insufficient data to assess trends.

Table 2 presents mean whole-water HCB concentrations collected from thirteen surveys conducted in the St. Clair-Detroit River Corridor in 2001 and 2002. In the Detroit River, whole-water levels of HCB at the Canadian downstream site (Amherstburg Channel) are the same as levels upstream, while concentrations in the Trenton Channel (on U.S. side) are higher than upstream levels. In the St. Clair River, whole-water levels of HCB are lower at the downstream sites than levels upstream. Section 3.2 discusses water quality criteria and exceedances.

Table 2. Mean Whole-water Concentrations of HCB (ng/L) based on Thirteen Surveys Conducted in St. Clair-Detroit River Corridor in 2001 and 2002

St Clair River			Detroit River		
Upstream	Downstream		Upstream	Downstream	
Inlet (Nav. Channel)	Roberts Landing	Port Lambton	Fleming Channel	Trenton Channel	Amherst. Channel
0.068	0.014	0.048	0.069	0.108	0.069

Reference: Waltho, 2005.

Water and suspended sediment samples from the St. Clair River have been analyzed for HCB since 1987 as part of the *St. Clair River Upstream/Downstream Monitoring Program*. This program is an ongoing project by Environment Canada to monitor water quality at the inlet and outlet of the main stream of the St. Clair River. Water and suspended sediments are collected once every two weeks from two permanent stations at Point Edward (the upstream station at the head of the St. Clair River) and Port Lambton (the downstream station at the mouth of the St. Clair River). Nutrients, major ions, metals, persistent organic contaminants, and selected herbicide information is collected.

Figures 6 and 7 present water and suspended sediment HCB concentrations at Point Edward and Port Lambton in the St. Clair River from 1987 to 1999.² In the St. Clair River, background concentrations of HCB in water at Point Edward (Lake Huron) remained stable around 0.02 ng/L. Downstream (Port Lambton) concentrations of HCB were much higher than the background concentrations upstream, and there was a gradual decline from 1987 to 1999 to the levels approaching background concentrations (Figure 6). In suspended sediments, trace amounts of HCB were found in the upstream station, but the downstream station had concentrations of 20-40 ng/g of HCB. Figure 7 presents a time plot of HCB in suspended

² Data analysis and interpretation provided by Waltho (2005).

sediments, showing a substantial decline (80%) from earlier concentrations at the downstream station.

St. Clair River upstream/downstream comparisons for HCB suggest historical local sources are still capable of impacting downstream water quality (Figure 7). However, the influence of these local sources has decreased substantially over the past 15 years (US EPA, 2004a).

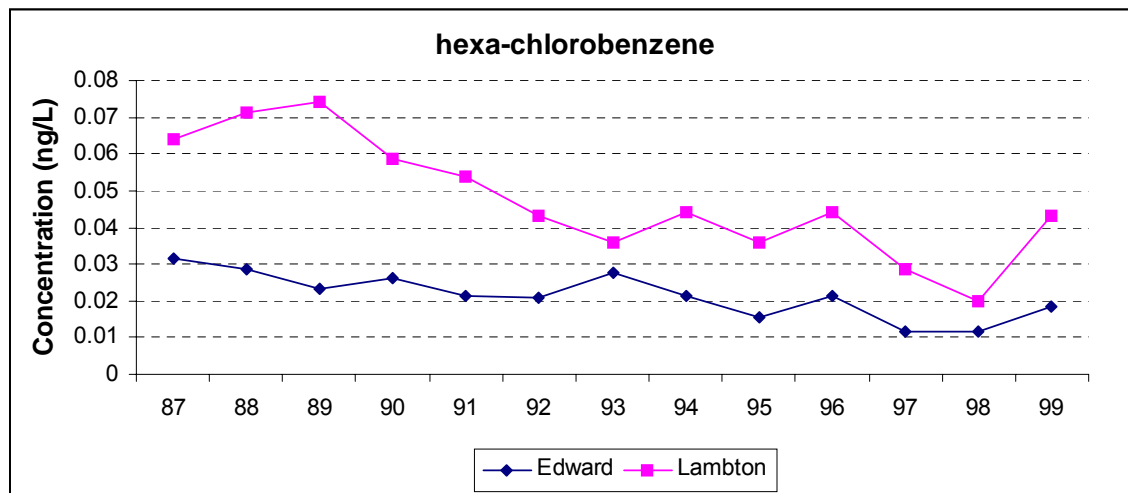


Figure 6. HCB Water Concentrations in the St. Clair River, 1987-1999³

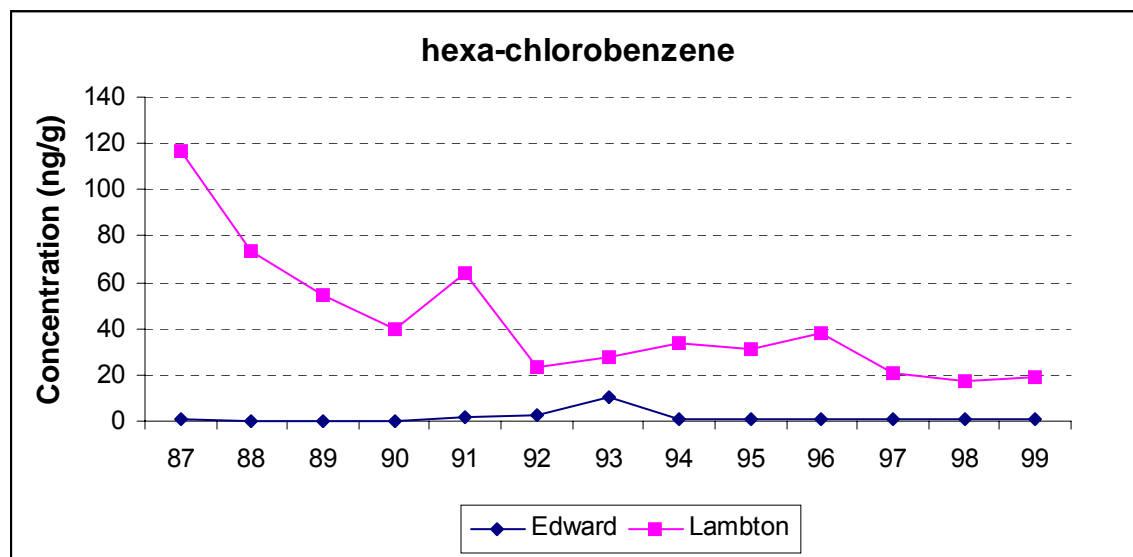


Figure 7. Suspended Sediment Concentrations of HCB in the St. Clair River, 1987-1999, at Upstream (Point Edward) and Downstream (Port Lambton) Locations⁴

³ Ibid.

⁴ Ibid.

Environment Canada has collected data on contaminant concentrations in suspended sediment and the dissolved phase since 1987 at Fort Erie and Niagara-on-the-Lake (both on the Niagara River), and since 1989 at Wolfe Island (on the St. Lawrence River). The data indicate that HCB levels in water and suspended sediment are declining at all three sites (see data in Table 1 under “Sediment” and “Open Water”). Figure 8 illustrates the decline of HCB in whole water at Niagara-on-the-Lake, the downstream station in the Niagara River (a whole water analysis combines measurements for water and sediment). At Fort Erie and Niagara-on-the-Lake, HCB levels have decreased 50 to 60 percent from 1987 to 2000. However, since 1995, HCB concentrations have remained relatively stable at Niagara-on-the-Lake.⁵ Greater declines in HCB concentrations are reported at Wolfe Island, with stable HCB water concentrations since 1995.⁶

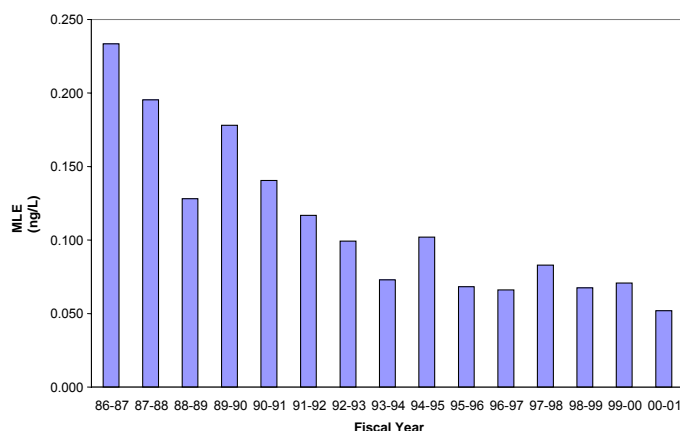


Figure 8. Whole Water HCB Concentrations (ng/L) at Niagara-on-the-Lake.⁷

The *Great Lakes Water Quality Surveillance Program* conducts spring and/or summer sampling cruises on Lake Superior, Lake Huron/Georgian Bay, Lake Erie, and Lake Ontario on a rotating schedule according to a standardized sampling regime coordinating with other programs. The lakes are sampled for a wide array of organic contaminants in addition to nutrients, major ions, physical and biological parameters. Table 3 presents data for HCB collected from 1986 to 2002 on Lakes Superior, Huron, Erie, and Ontario and Georgian Bay. Analysis of the data indicates decreasing trends in HCB levels on Lakes Huron, Erie, and Ontario and Georgian Bay. No trend is reported in the available data collected on Lake Superior from 1986 to 2002 (Waltho, 2005). See Section 3.2 for a comparison of the data to available criteria.

⁵ Trend analysis and percent changes were calculated by Environment Canada using the LifeReg model developed by El-Shaarawi and Ventressca (1998). Data analysis provided by Waltho (2005).

⁶ Ibid.

⁷ USEPA, 2004a.

Table 3. Great Lakes Water Quality Surveillance Program Data for HCB (ng/L), 1986-2002.

LAKE	LAKEWIDE MEANS*												
	1986	1987	1988	1990	1994	1995	1996	1997	1998	1999	2000	2001	2002
Superior	<0.04	<0.04					0.013	0.012				0.014	
Huron	ID	<0.04	0.07							0.015	0.011		0.008
Erie	0.05				0.02	0.02			0.01		0.02		0.013
Ontario	0.06		0.07	0.04					0.02	0.02		0.02	
Georgian Bay	ID	<0.04	0.04							0.013	0.009		0.012

* Data for 1986-1988 and 1990 are for whole water; data after 1990 are for the dissolved fraction. All data in ng/L. ID = Insufficient Data (i.e. Less than three reported values above the detection limit available to compute lakwide mean). Reference: Waltho, 2005.

Over the period 2001-2003, Environment Canada conducted screening level surveys of sediment quality in 101 Canadian tributaries to Lake Erie, including those into the St. Clair and Detroit River corridor and 211 Canadian tributaries to Lake Ontario, including the Niagara River and the St. Lawrence River. The sampling and analytical methodology for the surveys is described in Appendix B. The purpose of the screening level surveys was to assess sediment quality in each tributary prior to discharge into their respective receiving waters. The study was designed to maximize the probability of detecting PCBs, organochlorine pesticides, polycyclic aromatic hydrocarbons (PAHs), and metals in these tributaries, rather than quantify contaminant loads. Results were compared to existing federal and provincial sediment quality guidelines (CCME, 1999; Persaud et al., 1993) to determine compliance. The data provide information on the sediment quality of Canadian tributaries in the lower Great Lakes. Levels of HCB exceeded Ontario provincial sediment quality guidelines, indicating that sediments are marginally polluted (Waltho, 2005). The data collected for 2001-2003 are insufficient to generate reliable trend information.

Bottom sediment contaminant surveys conducted in the Great Lakes from 1997 to 2002 provide a good illustration of the spatial distribution of contaminants, and in concert with sediment cores, also provide a temporal perspective. Comparisons of surficial sediment concentrations with sub-surface maximum concentrations indicate that HCB concentrations have decreased by 38 percent in Lake Ontario and 49 percent in Lake St. Clair from 1997 to 2002. Data were not available to determine HCB trends in the other Great Lakes (US EPA, 2004a).

Sediment contamination also provides an indication of impacts of local historical sources, and through comparison to surveys conducted in the late 1960s and early 1970s, a regional perspective of the ambient environmental response to management initiatives. Open-lake bottom sediment contaminant information has been collected for all the Great Lakes. Historical sources and their impacts are evident through comparison to earlier work and by analysis of archived samples. The available open-lake sediment data for HCB in the lower Great Lakes illustrate a common theme. In general, the western basin of Lake Erie and the depositional basins of Lake Ontario exhibit the highest concentrations of HCB. These regional patterns reflect sediment characteristics, depositional processes, bathymetry, and location of historical sources (US EPA, 2004a).

Twelve Mile Creek/Old Welland Canal

The Ontario Ministry of the Environment (OMOE) and Environment Canada are jointly applying a “trackdown” strategy with the overall goal of determining whether observed concentrations of priority pollutants in major tributaries to the Great Lakes can be attributed to locally controllable sources, or whether they reflect recycled contaminants from diffuse historical sources. A pilot study, called *Project Trackdown*, responds to the Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem.

Three tributaries of Lake Ontario were selected for the pilot project: Twelve Mile Creek, Etobicoke Creek, and the Cataraqui River. Each tributary has previously exhibited some indication of elevated contaminant levels in water, sediment, or biological tissue relative to background conditions. Upstream/downstream differences in contaminant concentrations in each of these tributaries are in the process of being quantified using water, sediment, and juvenile fish data, and/or by quantifying differences in mussel (*Elliptio complanata*) tissue concentrations from selected points throughout each watershed.

Twelve Mile Creek was the first of the pilot projects to be studied. The creek has a relatively small watershed and more than 95 percent of the water entering the creek is Lake Erie water diverted through the Welland Canal. Table 4 presents levels of HCB in sediment collected at Twelve Mile Creek Old Welland Canal sites in 2003.

The data in Table 4 indicate that sediment quality is not impacted by HCB levels at Twelve Mile Creek Old Welland Canal tributary stations. Section 3.2 discusses criteria for HCB.

Table 4. Environment Canada HCB Sediment Data at 12-Mile Creek Old Welland Canal Sites, 2003.

TRIBUTARY STATIONS	LOCATION	SAMPLING DATE	HCB (µg/g)
Totem	Old Welland Canal	25-Aug-03	<0.002
		25-Aug-03	<0.002
Carter Creek	Old Welland Canal	25-Aug-03	<0.002
Dicks Creek	Old Welland Canal	25-Aug-03	<0.002
Richardsons Creek mouth (leading into Martindale Pond)		28-Aug-03	<0.002
First Street Louth	12 Mile Creek upstream Reference (like MOE's station 202)	28-Aug-03	<0.002
OWC Cliff	Old Welland Canal at Clifford Creek	20-Oct-03	<0.002
Glengary	OWC at Glengary Park	20-Oct-03	<0.002
		20-Oct-03	<0.002
Eastchester	Carter Creek, upstream of mouth	20-Oct-03	<0.002

Source: Ontario Ministry of the Environment (Boyd, 2005)

Integrated Atmospheric Deposition Network (IADN)

The Integrated Atmospheric Deposition Network (IADN) is a joint United States/Canada atmospheric monitoring network that has been in operation since 1990. The IADN consists of five master stations, one near each of the Great Lakes, and several satellite stations. Concentrations of PCBs, organochlorine pesticides, PAHs, and trace metals are measured in ambient air (gas phase), suspended particles, and precipitation at each station. These data are used to examine spatial and temporal trends of toxic contaminants in air and precipitation in the Great Lakes. It should be noted that HCB measurements (particularly those made using polyurethane foam as the sampling media) are highly uncertain because of HCB's proclivity for passing through the sampling media.

IADN data for HCB from the three U.S. master stations on Lakes Superior, Michigan, and Erie show decreasing trends with long half-lives of 15-29 years (Buehler et al. 2004), though concentrations increased somewhat during the late 1990s. As explained in Section 4.1.2, the increased concentrations in the late 1990s may be explained by El Niño-related events. Figure 9 presents annual average gas-phase HCB concentrations at U.S. sites from 1992 to 2002 (US EPA, 2004a). The longer than expected half-lives⁸ may be due to releases of HCB into the environment—from current sources, re-emission of HCB in soil and water, and/or long-range transport.

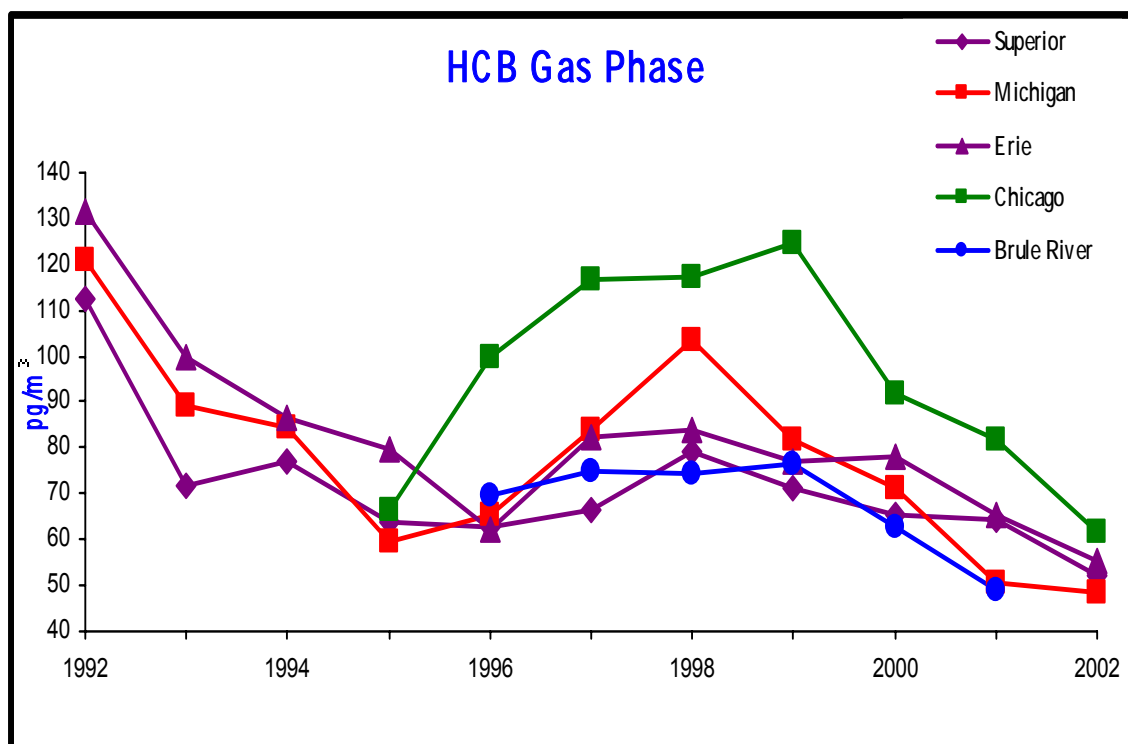


Figure 9. Annual Average Gas-Phase Hexachlorobenzene Concentrations (U.S. sites only) (pg/m³).⁹

⁸ HCB has an expected half-life of 2.7 to 6 years in the atmosphere (US EPA, 2000b).

⁹ IADN Steering Committee, unpublished data, 2004. Chicago and Brule River (on Lake Superior, now closed) are satellite stations. HCB data not available for Canadian stations due to breakthrough on polyurethane foam (PUF) sampling media.

Potential Source Contribution Function (PSCF) maps can estimate the general location of contaminant source regions impacting the basin. Figure 10 presents a back trajectory map for HCB in the Great Lakes. The figure was prepared using IADN data from Eagle Harbor, Sturgeon Point, and Sleeping Bear Dunes, from the date a station started operating through 2001.¹⁰ The red and pink boxes indicate areas that air parcels passed through which were more likely to result in higher HCB measurements at the IADN sites. The blue boxes indicate air parcel transit points that were less likely to result in higher HCB measurements. Appendix B provides a more thorough description of how Figure 10 was developed.

PSCF maps must be carefully interpreted, as pink and red areas can be source regions or areas that were passed through on the way to a resultant high measurement. Figure 10 shows that there is no well-defined source region for HCB, but that the Northeast and the Gulf Coast appear to be possible source regions for HCB in the Great Lakes. This is consistent with sources of HCB release reported to TRI. It is difficult to determine from the maps the contribution of HCB transported from beyond North America, since the back-trajectories only go back four days and thus do not show movement of air parcels before they reached North America. In addition, any long-range transport inputs could be masked by HCB picked up from sources closer to the site, such as pesticide application and residential burning.

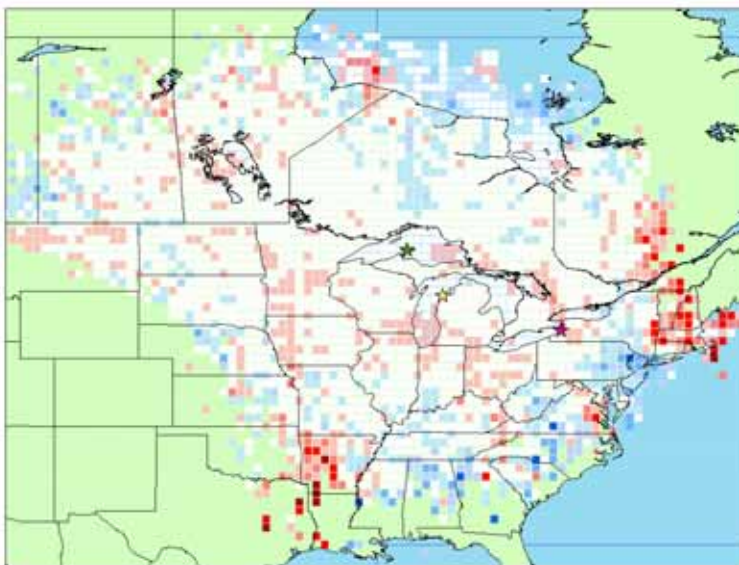


Figure 10. Back Trajectory Map of HCB Regions Impacting Eagle Harbor (green star), Sturgeon Point (pink star), and Sleeping Bear Dunes (yellow star) in the Great Lakes, from the start of operation through 2001.¹¹

¹⁰ The stations began operation at different times: Eagle Harbor began in November 1990; Sleeping Bear Dunes began in December 1991; and Sturgeon Point began in November 1991.

¹¹ Hafner and Hites, 2003.

National Air Pollution Surveillance (NAPS) Network

Through the National Air Pollution Surveillance (NAPS) network, data are collected on ambient air levels for a variety of toxics at rural, suburban, city-centre, and industrial sites in Canada. This effort is carried out in cooperation with provincial environmental and municipal agencies. The program includes measurement of many organic compounds and components of fine particulate matter (PM), including metals and inorganic and organic ions, and persistent, toxic semi-volatile organic compounds. One of the purposes of the monitoring effort is to provide data on trends in air concentrations of toxics and thus measure the success of initiatives carried out under the Toxic Substances Management Policy (TSMP) and the Canada-Ontario Agreement (COA) respecting the Great Lakes Basin Ecosystem.

Monitoring for HCB began in mid-1996 at most NAPS sites. HCB concentrations decreased significantly at urban sites from 1997 to 2002. For example, Figure 11 presents HCB concentrations at Windsor and Toronto from 1997 to 2002 (US EPA, 2004a). During the same period, HCB concentrations were relatively stable at rural sites. Median annual HCB concentrations at all sites in the Ontario Great Lakes Basin were similar, though the ranges in measured concentrations were higher at urban sites than at rural sites (Curren and Dann, 2004). HCB concentrations at urban sites appear to be decreasing to the relatively stable concentrations measured at rural sites (around 0.07 ng/m³).

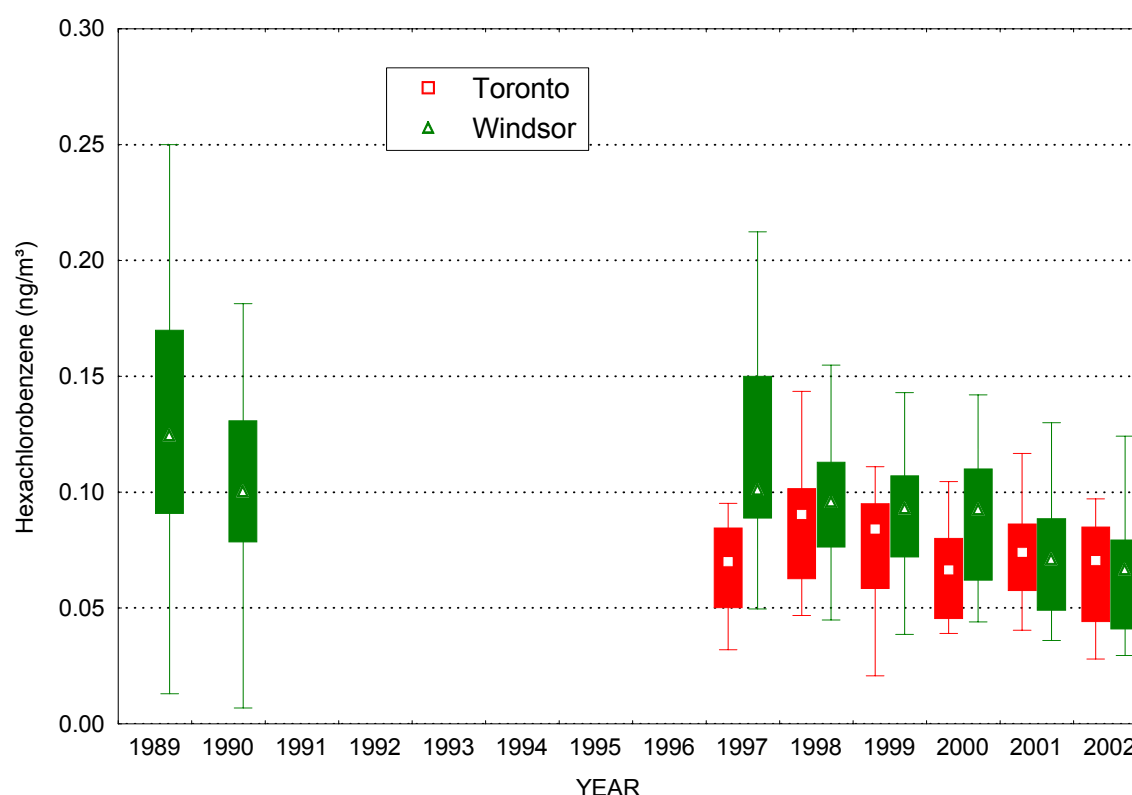


Figure 11. Trend in HCB Concentrations (ng/m³) at Windsor, Ontario (1989-2002).¹²

¹² Source: Tom Dann, Environment Canada Analysis and Air Quality Division. The box plots show median, 25th and 75th percentiles, and non-outlier minimum and maximum.

National Health and Nutrition Examination Survey (NHANES)

HCB concentrations in the U.S. human population are currently being measured by the Centers for Disease Control and Prevention (CDC) in the National Health and Nutrition Examination Survey (NHANES). NHANES provides an ongoing assessment of the U.S. population's exposure to environmental chemicals by measuring chemicals or their metabolites in human specimens such as blood or urine. The CDC issued the third *National Report on Human Exposure to Environmental Chemicals* in July 2005. The third report presents data for 1999-2000 and 2001-2002.

The third report presents serum lipid-based measurements of HCB measured in a subsample of 1,702 NHANES 1999-2000 participants aged 12 years and older, and a subsample of 2,277 NHANES 2001-2002 participants aged 12 years and older (CDC, 2005). The subsamples were randomly selected to be representative of the U.S. population. Serum levels of HCB were below detection in the NHANES 1999-2000 and NHANES 2001-2002 subsamples. The maximum level of detection for HCB measurements in NHANES 1999-2000 was 118 ng/g of lipid. The maximum level of detection for HCB measurements in NHANES 2001-2002 was 31.4 ng/g of lipid (CDC, 2005). There are no generally recognized criteria for HCB concentrations in human serum.

Other Studies of Great Lakes Human Tissue Levels

[Insert discussion of these studies]

Bloom, M. S., Vena, J. E., Swanson, M. K., Moysich, K. B., and Olson, J. R. (2005). Profiles of Ortho-Polychlorinated Biphenyl Congeners, Dichlorodiphenyldichloroethylene, Hexachlorobenzene, and Mirex Among Male Lake Ontario Sportfish Consumers: the New York State Angler Cohort Study. *Environmental Research* 97, 178-194.

Bloom, M. S., Weiner, J. M., Vena, J. E., and Beehler, G. P. (2003). Exploring Associations Between Serum Levels of Select Organochlorines and Thyroxine in a Sample of New York State Sportsmen: the New York State Angler Cohort Study. *Environmental Research* 93, 52-66.

Denham, M., Schell, L. M., Deane, G., Gallo, M. V., Ravenscroft, J., and Decaprio, A. P. (2005). Relationship of Lead, Mercury, Mirex, Dichlorodiphenyldichloroethylene, Hexachlorobenzene, and Polychlorinated Biphenyls to Timing of Menarche Among Akwesasne Mohawk Girls. *Pediatrics* 115, E127-E134.

Fitzgerald, E. F., Hwang, S. A., Deres, D. A., Bush, B., Cook, K., and Worswick, P. (2001). The Association Between Local Fish Consumption and Dde, Mirex, and Hcb Concentrations in the Breast Milk of Mohawk Women at Akwesasne. *Journal of Exposure Analysis and Environmental Epidemiology* 11, 381-388.

Kostyniak, P. J., Stinson, C., Greizerstein, H. B., Vena, J., Buck, G., and Mendola, P. (1999). Relation of Lake Ontario Fish Consumption, Lifetime Lactation, and Parity to Breast Milk Polychlorobiphenyl and Pesticide Concentrations. *Environmental Research* 80, S166-S174.

Health Canada Exposure Assessment

In 1998, Health Canada estimated the average daily intake of HCB for Canadian Great Lakes Basin residents (Health Canada, 1998). The assessment considers exposures to the population through ingestion of food and water, incidental ingestion of soil and house dust, and inhalation of ambient and indoor air. The assessment reports HCB exposures as ng/kg of bodyweight (bw) per day and compares them to Canada's Provisional Tolerable Daily Intake (PTDI) for HCB from food of 270 ng/kg bw/day. See Section 3.2 for a comparison of Health Canada's estimated average daily intake to the PTDI.

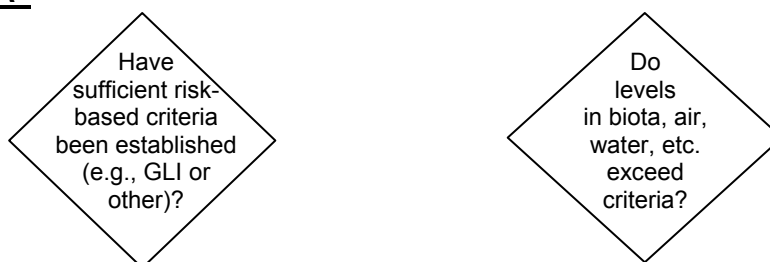
Canadian Total Diet Study

Since 1969, Health Canada has conducted Total Diet Studies, also known as Market Basket Surveys/Studies, for accurate estimates of dietary intakes of contaminants. To date, Total Diet Studies have been conducted in the following five time periods to estimate the levels of chemicals to which Canadians in different age-sex groups are exposed through the food supply:

- 1) 1969 – 1973
- 2) 1976 – 1978
- 3) 1985 – 1988
- 4) 1992 – 1999
- 5) Presently being conducted (began in 2000).

Each Total Diet Study is conducted in several major Canadian cities over the time period, normally one city each year. More information about the methods of sample collection and analysis can be found at http://www.hc-sc.gc.ca/food-aliment/cs-ipc/fr-ra/e_tds.html. See Section 3.2 for a discussion of the estimated dietary intake for HCB compared to Canada's PTDI.

3.2 CRITERIA



Criteria with which to assess the impact of HCB on the Basin are available for some but not all media. Criteria have been developed for HCB levels in fish tissue, food, water, and bulk sediment. There are no generally recognized criteria for HCB levels in whole fish, aquatic life, suspended sediment, air, or human tissue. However, the need to develop human health or ecological criteria with which to identify exceedances in these media is not a high-priority. Comparison of the data presented in Section 3.1 with available criteria indicates that **HCB levels in Great Lakes fish tissue and food are below available criteria, but exceedances of sediment and water quality criteria are observed.**

For contaminant concentrations in fish tissue, the US EPA has developed guidance documents to help state, local, regional, and tribal environmental health officials who are responsible for developing and managing fish consumption advisories. In these documents, US EPA issued risk-based monthly fish consumption limit tables for various chemicals. For HCB in the edible portion of fish, the carcinogenic health endpoint is 0.0018 mg/kg (wet weight) and the non-carcinogenic health endpoint is 0.23 mg/kg (wet weight) (US EPA, 2000a). There are currently (2003) **no fish advisories for HCB in the Great Lakes** limiting fish consumption.

In 1998, Health Canada estimated the daily intake of HCB for the general population, averaged over a 70-year lifetime, as 3.38 ng/kg bw/day, or 1 percent of the PTDI. HCB exposure is estimated to range from 1 percent of the PTDI (2.07 ng/kg bw/day) for adults to 17 percent of the PTDI (45.03 ng/kg bw/day) for breast-fed infants less than six months of age. For high sport-fish consumers, the lifetime average daily intake of HCB is estimated to be 1 percent of the PTDI (3.62 ng/kg bw/day) (Health Canada, 1998).

Data on HCB food concentrations and dietary intakes for Canadians are available for Total Diet Studies conducted in seven Canadian cities between 1993 and 1998. For example, in 1996, Health Canada measured the concentrations of HCB in fatty foods and the dietary intakes of HCB for different age-sex groups for the Toronto Total Diet Study. The average total dietary intake of HCB for all age groups from the seven cities surveyed in 1993-1998 was 0.24 ng/kg body weight/day (Health Canada, 2004). This estimated dietary intake is 0.1 percent of the PTDI for HCB.

In 1993, the Ontario Ministry of the Environment published *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario*. These Provincial Sediment Quality (PSQ) guidelines establish three levels of effect: no effect level (NEL), lowest effect level (LEL), and severe effect level (SEL). At the no effect level, substances have no toxic effects on aquatic organisms and exhibit no biomagnification through the food chain. At the lowest effect level, substances have no effect on the majority of benthic organisms, and the sediment is considered marginally polluted. At the severe effect level, substances have a significant detrimental impact on benthic organisms in the sediment. For HCB, a value of 0.01 µg/g has been established for the no effect level, the lowest effect level is 0.02 µg/g (ppm) dry weight, and the severe effect level is 24 µg/g organic carbon (MOE, 1993). Sediment data collected during 2001-2003 by EC in Canadian tributaries to Lakes Erie and Ontario exceeded the lowest effect level for HCB, indicating that the sediment is marginally polluted with no effect on the majority of benthic organisms.

Sediment data collected in 2003 at tributary stations to Twelve Mile Creek Old Welland Canal indicate HCB levels below the PSQ NEL. The data are presented in Table 4 and discussed in Section 3.1. These levels indicate that sediment quality at these sites is not impacted and no toxic effects are expected on aquatic organisms.

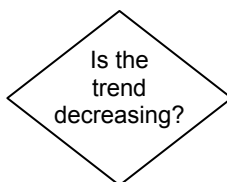
The US EPA has issued national recommended water quality criteria for protection of human health, pursuant to Section 304(a) of the Clean Water Act (US EPA, 2002). For HCB, the US EPA guideline for consumption of water is 0.28 ng/L. The Michigan Department of Environmental Quality (MDEQ) has established a water quality standard of 0.45 ng/L for HCB (MDEQ, 2003). The New York State Department of Environmental Conservation (NYSDEC) has established a stringent criterion for HCB in water of 0.03 ng/L (NYSDEC, 1999). This

criterion is based on non-oncogenic, human health considerations given the use of the waters as a drinking water source and the potential for fish consumption (Waltho, 2005).

Currently, exceedances of water quality criteria for HCB are restricted to exceedances of the NYSDEC criterion in the St. Clair, Detroit, and Niagara Rivers. Monitoring data (HCB in dissolved phase) collected by Environment Canada in the St. Clair River, Niagara River, and St. Lawrence River indicate exceedances of the NYSDEC criterion from 1987 to 1996 and in 1999 at Port Lambton, from 1987 to 1999 at Niagara-on-the-Lake, and in 1989 and 1990 at Wolfe Island. Mean whole-water concentrations of HCB based on thirteen surveys conducted in the St. Clair-Detroit River Corridor in 2001 and 2002 are below the US EPA and MDEQ criteria but above the NYSDEC criterion (at all sites except Roberts Landing). Similarly, the whole water data available for HCB levels at Niagara-on-the-Lake indicate concentrations below the US EPA and MDEQ criteria but above the NYSDEC criterion from 1987 to 2001. The Great Lakes Water Quality Surveillance Program data for HCB (1986-2002) show no exceedances of the MDEQ standard for HCB but a few exceedances of the NYSDEC criterion from 1986 to 1990 on Lakes Huron, Erie, and Ontario and Georgian Bay.

Despite the lack of well-established criteria in some media, HCB levels below the limit of detection indicate that current environmental levels likely do not present a significant adverse impact. Currently, an estimated 95 percent of whole fish lake trout samples have HCB levels less than the detection limit of 0.005 µg/g. HCB has not been detected in samples analyzed in the first two years of the U.S. National Fish Tissue Study. Rare instances of detection in human serum samples indicate low or non-existent HCB body burdens in the general U.S. population. In other media, such as air, water, herring gull eggs, and sediments, HCB levels have continued to decline and have not been associated with deleterious environmental impacts.

3.3 TRENDS



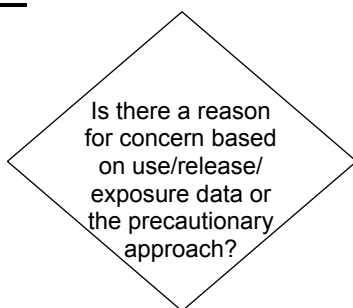
HCB levels in the Great Lakes environment are clearly decreasing, as evidenced by concentrations in whole fish, herring gull eggs, water, sediment, and ambient air. The data presented in Section 3.1 illustrate the following trends:

- Basinwide decline in whole fish lake trout samples to HCB levels below detection limit (< 0.005 µg/g).
- Percent declines ranging from 82.1 percent to 97.5 percent in HCB levels in herring gull eggs collected from Great Lakes waterbodies from 1974 to 2003.
- Decline of 80 percent in suspended sediment at Port Lambton, the downstream station in the St. Clair River from 1987 to 1999.

- Decline of 87 percent in suspended sediment at Wolfe Island and 76 percent decline in water from 1989 to 2000, but relatively stable HCB concentrations in water since 1995.¹³
- Declines of 50 to 60 percent in water and suspended sediment at Fort Erie and Niagara-on-the-Lake, from 1987 to 2000, but relatively stable HCB concentrations at Niagara-on-the-Lake since 1995.¹⁴
- Declining trends in the waters of Lakes Huron, Erie, and Ontario and Georgian Bay, 1986-2002. No trend in HCB levels in the open water of Lake Superior.
- Declines of 38 percent in Lake Ontario and 49 percent in Lake St. Clair bottom sediment from 1997 to 2002.
- Slowly declining concentrations from 1992 to 2002 in annual average gas-phase HCB at three IADN master stations on Lakes Superior, Michigan, and Erie in the U.S., though concentrations increased somewhat during the late 1990s and longer-than-expected half-lives were observed (15-29 years).
- Significant declines in HCB concentrations at urban NAPS sites in the Great Lakes from 1997 to 2002, but relatively stable HCB concentrations at rural sites during the same period.

With the exception of some slightly increasing gas-phase concentrations in the 1990s, the data portray overall decreasing trends in the Great Lakes environment. As explained in Section 4.1, Ma et al. (2003) suggest that El Niño-related events may explain the higher HCB air concentrations observed over the Great Lakes region in the late 1990s.

3.4 **EVIDENCE FOR CONCERN**



Although the data for HCB show decreasing environmental trends, this section considers possible reasons for concern about potential Basin effects based on documented use, release, exposure scenarios, or from a precautionary approach.

Section 4.1 identifies current sources of HCB in Ontario and the U.S. Sources in Ontario currently (2003) release an estimated 44 lbs (20 kg) of HCB (see Table 5 in Section 4.1.1). In the U.S., an estimated 2,911 lbs (1,323 kg) of HCB were emitted in 1999 (see Table 6 in Section 4.1.1).

In addition, national reporting systems in the U.S. and Canada indicate that facilities continue to release HCB. US EPA's TRI system reports that an estimated 1,211 lbs (550 kg) of HCB were released to air and 120 lbs (55 kg) of HCB were released to water in 2003. Canada's National

¹³ Trend analysis and percent changes were calculated by Environment Canada using the LifeReg model developed by El-Shaarawi and Ventressca (1998).

¹⁴ Ibid.

Pollutant Release Inventory (NPRI) system reports that 55 lbs (25 kg) of HCB were released to air in Canada and 0.0013 lbs (0.0006 kg) were released to water in 2003. This has decreased by over 38.5 lbs (17.5 kg) compared to 2002 releases. This decrease was mainly due to the temporary closure of the Métallurgie Magnola Inc. magnesium facility in Quebec, changes in production levels at the Noranda Incorporated - Brunswick zinc and lead smelter in New Brunswick, and the closure of the City of Hamilton's Solid Waste Reduction Unit (SWARU).

In addition to HCB releases from sources in the U.S. and Canada, long-range transport from elsewhere around the world can contribute to HCB in the Great Lakes. These releases appear to provide **little reason for concern about impacts to the Basin**, as the environmental data for HCB presented in the previous sections indicate declining trends and few criteria exceedances. However, for generation of a more precise release inventory, **releases of HCB should continue to be monitored**.

3.5 **ENVIRONMENTAL ANALYSIS CONCLUSIONS**

There are sufficient data on the environmental presence of HCB in multiple media to assess the impact of HCB in the Basin. Analysis of the environmental data for HCB has shown declining concentrations in various media (herring gull eggs, water, sediment, air), an absence of fish advisories in the Great Lakes, and HCB levels below detection in fish tissue and human serum in broad national surveys. However, individual research studies have found measurable levels of HCB in tissue samples of residents in the Great Lakes region, including blood and breast milk. A few exceedances of sediment and water quality criteria have been observed in recent years. Continued HCB releases and intercontinental transport may explain the longer-than-expected half-lives observed in air over the Great Lakes.

4.0 **GLBTS MANAGEMENT ASSESSMENT**

The key question to consider in the GLBTS management assessment of a Level 1 substance is whether the GLBTS can effect further reductions. To answer this question, this section briefly summarizes sources of HCB, current regulations and programs, and reduction opportunities.

4.1 **SOURCES**

4.1.1 **Current Known Sources**

Ontario Emissions

In Ontario, the largest sources of HCB are from pesticide application (volatilization of HCB as a microcontaminant) and the open burning of residential household waste, with a total estimated release of 30 lbs (13.8 kg) of HCB per year. The use of ferric/ferrous chloride (for wastewater treatment) containing trace levels of HCB is estimated to release an additional 3 lbs/yr (1.4 kg/yr), while the remaining releases are estimated at 11 lbs/yr (5 kg/yr). Table 5 provides estimated releases of current known sources of HCB in Ontario.

Table 5. Current Known Sources of HCB in Ontario, and Estimated Releases

Known Source	Percent Release	Release Estimate (kg/year)	Release Estimate (lbs/year)
Ontario Sources (2003 estimates)			
Pesticide Application	49%	10.1	22
Open Burning – Residential Household Waste	19%	3.7	8.1
Use of Ferric/Ferrous Chloride Containing Trace HCB Levels	7%	1.4	3.1
Iron & Steel	5%	0.95	2.1
Cement Production	5%	0.93	2.0
Sewage Effluent/Sludge to Land	5%	0.90	2.0
Wood/Biomass Burning	3%	0.68	1.5
Waste Incineration	1%	0.26	0.57
Other	7%	1.3	2.9
TOTAL	100%	20.2	44.3

Reference: Environment Canada 2003 Release Update

U.S. Emissions

Table 6 provides estimated air emissions of current known sources of HCB in the U.S. The application of pesticides containing trace levels of HCB and wastewater treatment (including publicly owned treatment works, POTWs)¹⁵ each are estimated to contribute approximately 30 percent of the U.S. inventory for HCB. HCB emissions generated as a microcontaminant in the manufacture of plastics material, industrial organic chemicals, and other chemicals contribute approximately 19 percent of the U.S. inventory. Residential burning of household waste is estimated to account for 16 percent of HCB emissions.

HCB emissions from pesticide application directly impact the Great Lakes Basin. Chlorothalonil is one pesticide that may contain HCB as an impurity. In a study of agricultural pesticide use in the Great Lakes Basin (Brody et al., 1998), chlorothalonil was found to be used in the Lake Erie basin and to be among the top pesticides used in the Lake Superior basin. The regions most affected by pesticide application appear to be the western Lake Erie and southern Lake Michigan basins, primarily due to the amount of acreage used for agricultural purposes, as compared to other Great Lakes basins (US EPA, 1999).

¹⁵ The reliability of the estimate for POTWs is uncertain. The data are from two counties in Florida and could not be verified.

Table 6. Current Known Sources of HCB in the U.S., and Estimated Air Emissions

Known Source	Percent Release	Release Estimate (kg/year)	Release Estimate (lbs/year)
U.S. Sources (1999 estimates)			
Pesticide Application	31%	407	896
Publicly Owned Treatment Works ¹	29%	382	841
Open Burning - Residential, Household Waste	16%	211	464
Plastics Material and Synthetic Resins, and Nonvulcanizable Elastomers	9%	119	261
Industrial Organic Chemicals ²	6%	83	183
Chemicals and Chemical Preparations	4%	50	111
Wastewater Treatment, all Sectors	1%	17	37
Cement, Hydraulic	1%	9	20
Other	3%	45	98
TOTAL³	100%	1,323	2,911

Reference: US EPA 1999 National Emissions Inventory updated with 1999 pesticide application emissions data (US EPA, 2004a).

¹ The reliability of the estimate for POTWs is uncertain. The data are from two counties in Florida and could not be verified.

² The NEI estimate of 1,147 lbs (521 kg) for this sector was corrected using the 1999 TRI estimate of 5 lbs (2.3 kg) submitted by Vulcan Materials Company.

³ The total excludes 7,458 lbs (3,390 kg) of emissions from Onyx Environmental Services (refuse systems) because these emissions could not be verified.

The reliability of the estimate of HCB emissions from POTWs is uncertain. The inventory estimate in Table 6 includes data from two counties in Florida and could not be verified. Results of testing at Canadian POTWs show low levels of HCB. In 1987, the Ontario Ministry of the Environment conducted a pilot monitoring study with 37 municipal water pollution control plants with 5-10 samples per facility (MOE, 1988). Data from the study showed 4 percent of influent samples with detectable levels and no effluent samples with detectable levels. Raw and treated sludge samples did have detectable levels at higher frequencies. In 1997 and 1998, a small monitoring study was conducted using 20 municipal water pollution control plants in Ontario with 1-3 samples per facility (Khettry and EC, 2000). The 1997-1998 study shows that HCB may be lower than the levels measured in 1987.

Open burning of residential household waste is known to occur in the Great Lakes Basin. Some estimates of the prevalence of this practice in areas of the Basin have been made. Open burning of residential household waste is also a source of dioxins/furans, B(a)P, and other contaminants.

The point sources included in the following three source categories of HCB are located outside of the Great Lakes region: 1) Plastics Material and Synthetic Resins, and Nonvulcanizable Elastomers; 2) Industrial Organic Chemicals; and 3) Chemicals and Chemical Preparations. However, as indicated in Figure 10, source regions outside of the Basin can impact HCB measurements at IADN sites on the Great Lakes.

4.1.2 Long-Range Transport of HCB

HCB is volatile and has an atmospheric lifetime of about two and a half years (Brubaker and Hites, 1998), which makes it capable of global transport. Atmospheric transport of HCB from regions outside of North America has been shown to contribute to HCB air concentrations over the Great Lakes (Cohen, et al., 1995). HCB is thought to be widely distributed in the global atmosphere (Shen et al., 2005) with global emissions estimated at 50,600 lbs (23,000 kg) (Bailey, 2001). However, the magnitude of global HCB contributions to the Great Lakes is uncertain.

Ma et al. (2003) suggest that the release of HCB from sources in the U.S. and Canada is not a major contributor to measured air concentrations around the Great Lakes. Ma et al. (2003) correlated El Niño-Southern Oscillation (ENSO) events with HCB air concentrations over the Great Lakes. Higher average surface air temperatures during warm-phase ENSO events may increase volatilization of HCB and explain the higher HCB air concentrations observed over the Great Lakes region in the late 1990s. Circulation patterns during these ENSO events may also increase long-range transport of HCB into the Great Lakes region. Ma et al. (2003) expect the re-emission of HCB in soil and water from past use/release, followed by long-range transport, to increasingly contribute to HCB air concentrations at any one location; however, the authors were not able to positively identify the contribution of long-range transport from specific major sources or the location of specific major sources of HCB re-emission from soil.

Researchers at the Department of Energy's (DOE) Lawrence Berkeley National Laboratory investigated the North American and global scale transfer efficiencies of Level 1 substances to the Great Lakes using the Berkeley-Trent (BETR) contaminant fate modeling framework (MacLeod et al., 2005). The modeling results indicate that HCB is subject to global-scale transport and redistribution, and that global emissions of HCB likely contribute to deposition in the Great Lakes. Although a hypothetical emission of HCB in the Great Lakes region is transferred to the Great Lakes about 12 to 60 times more effectively than a hypothetical emission outside of North America, the modeling results cannot estimate the fraction of total HCB loading from the atmosphere that is attributable to sources in different regions of North America and the world without North American and global emissions estimates. At this time, there are no adequate spatially resolved North American or global emissions inventories for HCB.

The BETR model describes contaminant fate and partitioning in the environment using mass balance equations based on the fugacity concept. Therefore, it inherently treats the effect of atmospheric transport based on annual *average* winds and "residence times" in a given grid cell or region. Ma et al. (2003) correlate strong variations in HCB concentrations in the Great Lakes region to strong changes in global circulation patterns caused by climate anomalies. Short period episodes with winds from a direction conducive to strong transport can have a major impact on the transport of a given substance from its source regions to the Great Lakes Basin (a direct impact on transfer efficiency to the Great Lakes). Both MacLeod et al. (2005) and Ma et al.

(2003) provide a better understanding of the issues and the factors that impact long-range transport by using two different approaches.

4.2 OPPORTUNITIES TO ACHIEVE FURTHER REDUCTIONS

This section considers current programs and regulations in place to address known sources of HCB and assesses potential opportunities for the GLBTS to effect further reductions.

The re-emission of HCB in soil and water from past use/release has been proposed as a significant source of HCB measured in the environment (Bailey, 2001). The HCB Workgroup has deferred the remediation of HCB-contaminated soils and sediments to government programs such as US EPA's Superfund and sediment remediation projects in the U.S. and Canada (e.g., in Great Lakes Areas of Concern).

The application of pesticides containing HCB is one area where improvements may be possible in the basin. The certainty of the HCB release inventory from pesticides application has been improved. In Ontario, HCB releases from pesticide application have decreased by 72 percent since 1988. There may be other opportunities to further achieve reductions.

It is uncertain whether there are opportunities to work with POTWs. The HCB Workgroup has been unable to confirm HCB emissions from POTWs reported in the U.S. inventory. As discussed in Section 4.1, a study of toxic releases from Ontario sewage treatment plants found no effluent samples with detectable levels of HCB.

The HCB Workgroup has encouraged reductions of HCB emissions from the chemical manufacturing sector. This includes facilities reporting the release of HCB from the manufacture of industrial organic chemicals, plastics, and other chemicals. Chemical manufacturers have reduced HCB emissions, and further reductions appear more difficult to achieve.

There may be an opportunity to reduce HCB emissions from the use of products containing trace levels of HCB, particularly wood treated with pentachlorophenol (penta or PCP). The average HCB content of penta produced by the two North American producers is somewhat variable, but 50 ppm is considered representative of average production. Full lifecycle management of PCP-treated wood products presents one opportunity to reduce HCB releases.

Other reductions in HCB may be effected through work being done in conjunction with other GLBTS workgroups. For example, the efforts of the GLBTS Burn Barrel Subgroup to decrease open burning practices will likely reduce HCB as well as dioxin emissions.

Table 7 identifies current programs or regulations and reduction opportunities for known sources of HCB.

Table 7. Current Programs or Regulations and Reduction Opportunities for Known Sources of HCB

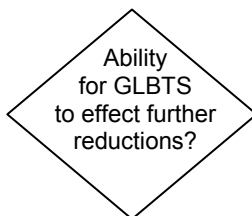
KNOWN SOURCE	CURRENT REGULATIONS OR PROGRAMS	GLBTS OPPORTUNITIES
Pesticide Application	- Regulatory limits on maximum HCB levels in pesticides - HCB Workgroup inventory work	Continue to refine release estimates
Publicly Owned Treatment Works/ Wastewater Treatment		Verify emission estimates
Burn Barrels / Open Burning of Household Waste	GLBTS Burn Barrel Subgroup	Continue subgroup efforts
Industrial Organic Chemicals	US EPA regulations	Encourage further reductions by manufacturers
Plastics Material and Synthetic Resins, and Nonvulcanizable Elastomers	US EPA regulations	Encourage further reductions by manufacturers
Chemicals and Chemical Preparations	US EPA regulations	Encourage further reductions by manufacturers

4.3 OTHER SUBSTANCE-RELATED OPPORTUNITIES FOR THE GLBTS

While HCB has the potential to be transported globally, the magnitude of global HCB emissions that are deposited in the Basin is uncertain. The GLBTS should continue to assess the impact of long-range transport of HCB.

Water and sediment monitoring programs show that HCB levels have declined significantly in the Niagara and St. Clair Rivers, both areas of historic HCB contamination. Environmental monitoring data does suggest, however, that historical local sources may still be capable of impacting downstream water quality. The GLBTS should continue to support the remediation of priority sites in the Basin containing HCB-contaminated sediments, and verify the adequacy of the remediation efforts in eliminating future releases from these historic sources.

4.4 GLBTS OPPORTUNITY ASSESSMENT CONCLUSIONS



While both Canada and the U.S. have achieved reductions of HCB, **a number of opportunities for further GLBTS action are identified** in Sections 4.2 and 4.3.

GLBTS HCB Workgroup opportunities include:

- Continue to refine HCB emission inventory estimates, i.e. from pesticide application, chemical manufacturing, and POTWs;
- Encourage additional emission reductions from pesticide application and chemical manufacturing, where possible;
- Support other actions which impact HCB releases. For example: (i) Household Garbage Burning Strategy in the Great Lakes Basin (GLBTS Burn Barrel Subgroup); (ii) Full lifecycle management of PCP-treated wood products.

Other GLBTS opportunities include:

- Continue to assess the impact of long-range transport of HCB and its impact on the Basin;
- Continue to support the remediation of priority sites in the Basin containing HCB-contaminated sediments, and verify the adequacy of the remediation efforts in eliminating future releases from these historic sources;
- Continue to support the collection of data on HCB levels in the environment.

5.0 **MANAGEMENT OUTCOME**

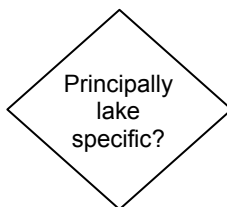
This section presents the final management outcome resulting from the combined environmental and GLBTS opportunity assessment.

5.1 REFERRAL OR PARTICIPATION IN ANOTHER FORUM

The potential for HCB to be transported long distances makes HCB contamination a global issue. The GLBTS will coordinate activities with the Stockholm Convention, the Convention on Long-range Transboundary Air Pollution (LRTAP), and other international programs. For instance, as part of the Sound Management of Chemicals Program, the North American Commission for Environmental Cooperation (CEC) is developing a North American Regional Action Plan on

Dioxins and Furans, and Hexachlorobenzene. Coordination of GLBTS efforts with international programs may be an effective way to reduce HCB concentrations in the environment.

5.2 NUMBER OF LAKES IMPACTED



HCB concentrations appear to show an overall decreasing trend in the Great Lakes environment. **HCB levels are not a lake-specific concern.**

5.3 NEW CHALLENGE GOALS



Establishing new challenge goals for HCB does not appear practical. The present Canadian goal of a 90 percent reduction is extremely challenging. The overall HCB reduction in Ontario is expected to change little by 2006 from the estimated 62 percent reduction. Setting a new challenge goal provides no added benefit towards achieving further HCB reductions in Ontario.

Considerable progress has also been made in the U.S. to reduce HCB releases (see Section 2.0). Setting a more definitive target for the U.S. challenge goal that is both realistically feasible and estimated to have a reasonably significant beneficial impact on the environment or human health would require an assessment of the potential for further reductions and the anticipated impact on the environment. It appears that the present challenge goal has been effective in motivating actions to reduce HCB releases and corresponding levels in the environment.

5.4 FINAL RESULT

The final management outcome for HCB is **continued active Level 1 status** with reassessment in 2008 by the GLBTS. The GLBTS HCB Workgroup will:

- 1) Resolve inventory discrepancies, particularly for pesticide application, chemical manufacturing and combustion sources, so that Basin and national progress in reducing HCB emissions can be tracked;
- 2) Identify the impact of long-range transport to the Great Lakes so that the contribution of US and Ontario sources can be determined;
- 3) Coordinate with international programs (e.g., Stockholm Convention, LRTAP) to manage HCB globally;

- 4) Obtain all possible HCB emission reductions in the US and Ontario, consistent with the Strategy's objective of virtual elimination;
- 5) Form an emission inventory subgroup, probably one subgroup for all Level 1 substances;
- 6) Establish sector subgroups for any major sector that remains a significant contributor;
- 7) Expand the HCB Workgroup to include chlorobenzenes; and
- 8) Determine the best way to coordinate with the GLBTS Dioxin Workgroup.

A reassessment of HCB will be undertaken in 2008 using the *General Framework to Assess Management of GLBTS Level 1 Substances*, until the Parties decide that HCB has been virtually eliminated.

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**APPENDIX A: GENERAL FRAMEWORK TO ASSESS
MANAGEMENT OF GLBTS LEVEL 1 SUBSTANCES:
BACKGROUND, OBJECTIVES, AND DOCUMENTATION**

General Framework to Assess Management of GLBTS Level 1 Substances: Background, Objectives, and Documentation

BACKGROUND

Over the past thirty years, the governments of Canada and the United States have joined together with industries, citizen groups, and other stakeholders in a concerted effort to identify and eliminate threats to the health of the Great Lakes ecosystem resulting from the use and release of persistent toxic substances. A major step in this process was the enactment of the *Revised Great Lakes Water Quality Agreement (GLWQA)* of 1978 which embraced, for the first time, a philosophy of “virtual elimination” of persistent toxic substances from the Great Lakes. In 1987, the GLWQA was amended, establishing Lakewide Management Plans (LaMPs) as a mechanism for identifying and eliminating any and all “critical pollutants” that pose risks to humans and aquatic life. In 1994, the International Joint Commission’s *Seventh Biennial Report* under the GLWQA called for a coordinated binational strategy to “stop the input of persistent toxic substances into the Great Lakes environment.” This led to the signing of the *Great Lakes Binational Toxics Strategy* (GLBTS, or Strategy) in 1997. The Strategy specifies Level 1 substances, each targeted for virtual elimination and each with its own specific challenge goals, along with Level 2 substances targeted for pollution prevention. The substances were selected on the basis of their previous nomination to lists relevant to the pollution of the Great Lakes Basin, and the final list was the result of agreement on the nomination from the two countries. The specific reduction challenges for each substance include individual challenge goals for each country, within a time frame that expires in 2006.

Significant progress has been made toward achieving the Strategy’s challenge goals. As 2006 approaches, an analysis of progress and determination of next steps is needed to respond to the mandate set forth in the Strategy. The purpose in developing the *General Framework to Assess Management of GLBTS Level 1 Substances* is to provide a tool to assist the Parties (Environment Canada and US EPA) and stakeholders in conducting a transparent process to assess the Level 1 substances.

OBJECTIVE

The framework presents a logical flow diagram for evaluating progress and the need for further action by the GLBTS on the Level 1 substances in order to meet the following objective:

Evaluate the management of GLBTS Level 1 substances with the following potential outcomes:

- 1) Active Level 1 Status & Periodic Reassessment by GLBTS**
- 2) Consider Submission to BEC¹⁶ for New Challenge Goals**
- 3) Engage LaMP Process**

¹⁶ The Binational Executive Committee (BEC) is charged with coordinating implementation of the binational aspects of the 1987 Great Lakes Water Quality Agreement, including the GLBTS. The BEC is co-chaired by EC and US EPA and includes representatives from the Great Lakes states and the Province of Ontario, as well as other federal agencies in Canada and the U.S.

- 4) Suspend GLBTS Workgroup Activities. Where warranted, refer to another program and/or participate in other fora. Periodic Reassessment by GLBTS, until Parties determine substance has been virtually eliminated.**

Additional outcomes that may result from the framework are:

- **Recommend benchmark or criteria development as a high priority; and**
- **Recommend additional environmental monitoring as a high priority.**

The framework is intended to serve as a guide in determining the appropriate management outcome(s) for the Level 1 substances: mercury, polychlorinated biphenyls (PCBs), dioxins and furans, hexachlorobenzene (HCB), benzo(a)pyrene (B(a)P), octachlorostyrene (OCS), alkyl-lead, and five cancelled pesticides: chlordane, aldrin/dieldrin, DDT, mirex, and toxaphene. The framework is not intended to specify details of how a Level 1 substance should be addressed once a management outcome is determined.

STRUCTURE OF THE FRAMEWORK

The framework is set up in a hierarchical fashion to allow efficiencies in the decision process. The hierarchy of the framework is to first consider progress toward the challenge goals committed to in the Strategy, then to conduct an environmental analysis and finally, a GLBTS management assessment which leads to various potential management outcomes for a substance.

The environmental analysis (depicted in green) and the GLBTS management assessment (depicted in blue) comprise the two main parts of the framework. The environmental analysis considers available Canadian and U.S. monitoring data and established human health or ecological criteria as the primary basis for an objective evaluation of a substance's impact on the Basin. For substances lacking sufficient risk-based criteria or environmental monitoring data, the framework recommends the development of benchmarks or criteria and additional monitoring as a high priority. While the environmental analysis places emphasis on good monitoring data, evidence of use, release, exposure, or precautionary concerns may also be considered.

If the environmental analysis concludes that there is no basis for concern, GLBTS workgroup activities may be suspended, with periodic reassessment of the substance until the Parties determine that the substance has been virtually eliminated. If, on the other hand, the environmental analysis concludes that there is a reason for concern, the GLBTS management assessment evaluates the ability for the GLBTS to effect further improvements in and out of the Basin. The GLBTS management assessment also considers whether the impact of a substance is basinwide or restricted to a single lake. In cases where the GLBTS can effect further reductions, consideration will be given as to whether new Strategy challenge goals can be established. Virtual elimination is an underlying tenet of the Strategy and should be kept in mind throughout the assessment process.

The GLBTS management assessment can result in a number of potential management outcomes; the outcomes provided in the framework allow a substance to remain in active Level 1 status or GLBTS workgroup activities to be suspended. The outcomes also recognize that it may be appropriate to more actively involve a LaMP process, to refer a substance to another program, to represent GLBTS interests in other fora (e.g., international programs), or to consider proposing new challenge goals. All outcomes include a periodic reassessment by the GLBTS (approximately every two years).

While it is recognized that the Parties have an ongoing responsibility to promote GLBTS interests in other arenas, a potential outcome of the framework is to recommend referral to another program and/or GLBTS representation in other fora. In the GLBTS framework, this option is presented when there is no evidence of Basin effects, or when the GLBTS cannot effect further significant reductions on its own, but can advocate substance reductions in other programs and in international fora.

It should be noted that, in using the framework to conduct assessments for the Level 1 substances, it may not be possible to definitively answer “YES” or “NO” to all questions. It is not necessary to have a definitive answer to proceed in the framework. For example, in assessing whether there is environmental or health data to assess the impact of the substance in the Basin, it may be determined that, while additional data would be helpful, there is some data on releases and environmental presence in certain media with which to assess the status of the substance. In this case, judgment is needed to decide whether these data are sufficient to proceed along the “YES” arrow or whether the available data are not adequate and the analysis should proceed along the “NO” arrow, placing the substance on a high priority list for monitoring. As a general guide, the framework allows flexibility and judgment in interpreting environmental data and in determining the most appropriate management outcome(s).

Each decision node, or shape, in the framework is illustrated below along with a brief explanation that describes, in further detail, the question to be assessed.

GLBTS Level 1 Substances

Have the challenge goals for the substance been met?

All 12 Level 1 substances will be assessed.

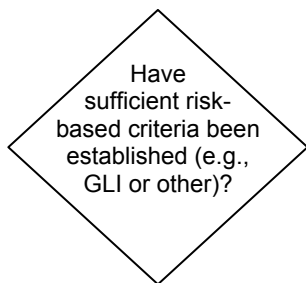
The first question to consider in assessing the GLBTS status and future management of a Level 1 substance is whether the challenge goals agreed to in the Strategy have been met. The answer to this question informs the subsequent assessment in many ways, not only indicating progress, but also revealing issues associated with the ability to pursue further reductions. Progress toward the U.S. and Canadian goals will be considered jointly. Challenge goals will be evaluated with the best data presently available. Note that some challenge goals target “releases” of a substance while others target its “use”. As a result, different types of data may be required to evaluate challenge goal status (e.g., “use” data vs. environmental “release” data). The framework continues with both the environmental analysis and GLBTS management assessment, notwithstanding the status of the challenge goals.

ENVIRONMENTAL ANALYSIS



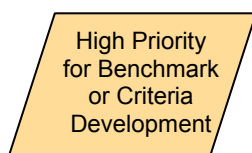
Characteristics of acceptable monitoring data to assess the temporal, spatial, and population representativeness of a substance in the Great Lakes Basin ecosystem include (but are not limited to) basin-specific measures in water, air, sediment, soil, indoor environments (e.g., dust), fish, biota, or human biological samples. If necessary, use or release data may be used as surrogates (e.g., in the case of alkyl-lead).

“What gets measured gets managed.” Substances entering this box will be recommended as a high priority for monitoring to the Parties. The intent is that these GLBTS substances will be considered by a wide range of government or private agencies when they make decisions regarding which analytes to monitor in the environment. As sufficient monitoring data is developed, substances will be re-evaluated.

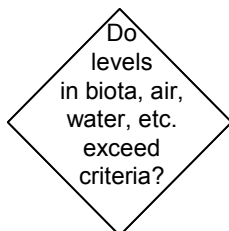


Relevant criteria include, but are not limited to:

- Water quality criteria
- Fish tissue concentrations
- Ambient or indoor air standards
- Sediment or soil standards
- Limits based on reference doses
- Health-based standards for human biota measurements



If there are no criteria against which to evaluate current levels, the GLBTS will consider whether there is a need for the Parties to recommend the development of human health or ecological criteria. This box effectively creates a GLBTS list of substances that are in need of human health or ecological criteria with which to identify exceedances in the environment.

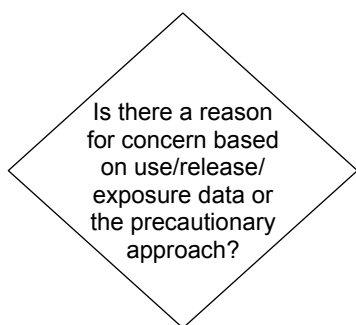


As the framework is intended to be flexible in its implementation, the choice of criteria to use in answering this question may vary. For example, the most strict criteria in one or more media may be used to evaluate environmental levels.



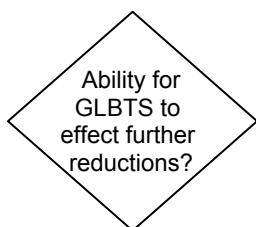
If there are no criteria, or if current levels do not exceed criteria, this box considers whether there is a decreasing trend. A decreasing trend could be defined as a statistically significant negative slope. If the trend is decreasing, the substance is evaluated for evidence of concern based on use, release, exposure, or the precautionary approach. If a decreasing trend cannot be established, then the substance moves directly to the GLBTS management assessment to determine the ability of the GLBTS to effect further reductions.

* Note that, in the event that there are established criteria and the GLBTS substance is below those criteria but not decreasing in trend, further analyses may be required to estimate when criteria might be exceeded.

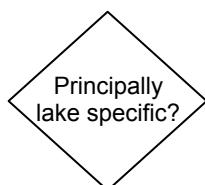


In cases where sufficient monitoring data is not available, or where environmental trends are decreasing and criteria have either not been established or are not being exceeded, the relevant question is whether there is evidence of Basin effects based on documented use, release, or exposure data, or from a precautionary point of view. An example of a precautionary point of view would be documented evidence of significant impact in another geographic location with the same sources and use patterns as in the Basin, or because the effects of a pollutant would be significant by the time it was able to be measured through monitoring.

GLBTS MANAGEMENT ASSESSMENT



Answering this question involves an accelerated version of the first three steps of the GLBTS 4-step process,¹⁷ looking at sources and current programs and regulations to see where the reduction opportunities lie. Part of the assessment will involve consideration of whether the reduction opportunities will be significant enough to merit the effort.



Based on a joint GLBTS-LaMP determination that the impact of a substance is restricted to a single lake, the appropriate LaMP will be engaged for coordination of leadership for reduction actions to be undertaken by the responsible organizations.



The GLBTS will assess the practicality of setting forth new challenge goals.

¹⁷ The GLBTS four-step process to work toward virtual elimination is: 1) Information gathering; 2) Analyze current regulations, initiatives, and programs which manage or control substances; 3) Identify cost-effective options to achieve further reductions; and 4) Implement actions to work toward the goal of virtual elimination.

GLBTS MANAGEMENT OUTCOMES

Active
Level 1
Status &
Periodic
Reassessment
by GLBTS

The substance will continue as a Level 1 with reduction actions addressed by the appropriate process and with periodic reassessment, approximately every two years, using the *General Framework to Assess Management of GLBTS Level 1 Substances*.

Consider
Submission
to BEC for
New
Challenge
Goals

The GLBTS will consider recommending new challenge goals to BEC. The justification for new challenge goals will incorporate the findings of the framework analysis and will include assessment of the desired environmental improvement and feasibility. If the GLBTS decides to propose new challenge goals, the recommendation to BEC will include a reduction percentage, reduction timeline, and baseline for the proposed new challenge goals.

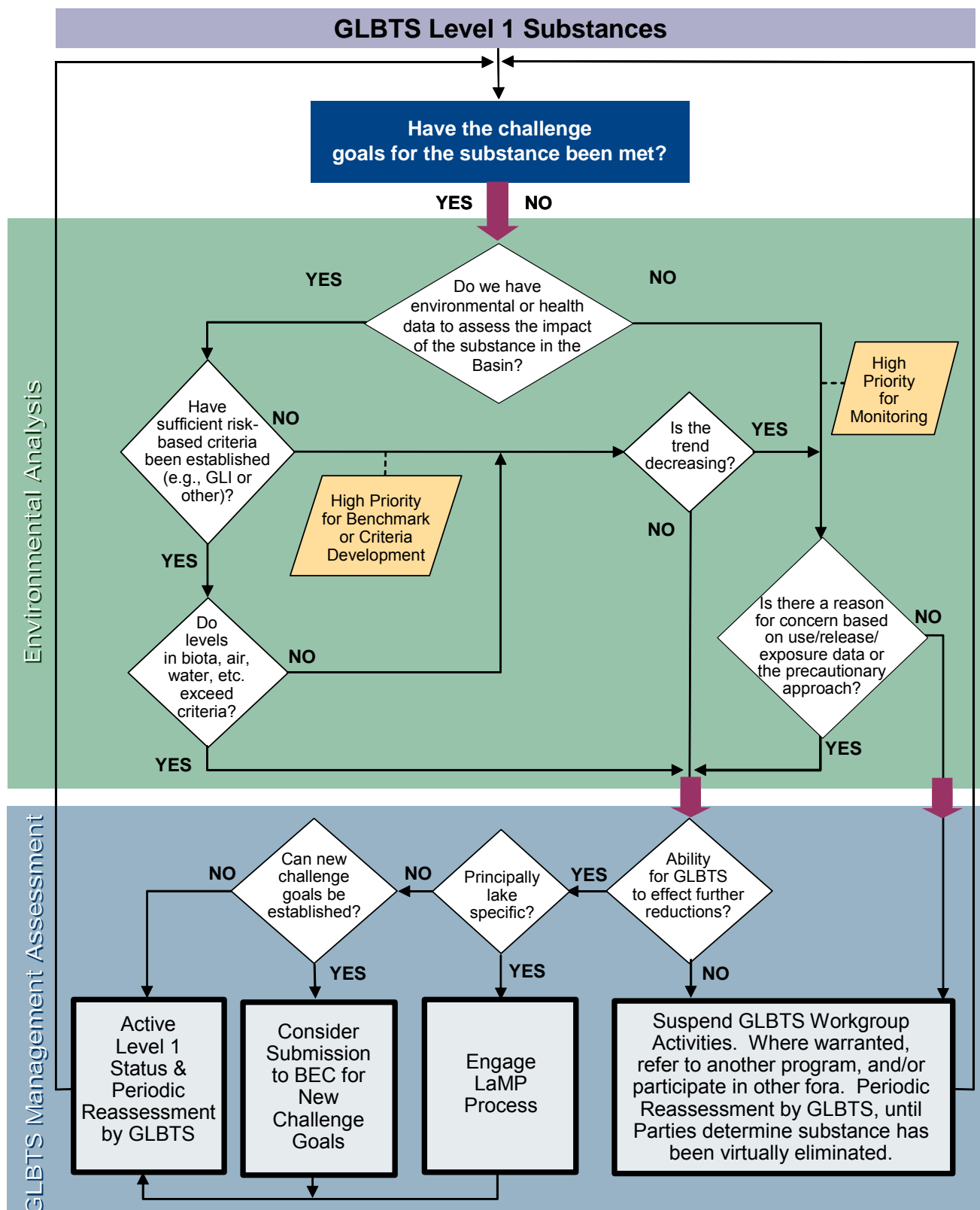
Engage
LaMP
Process

For substances whose impact is lake-specific, the appropriate LaMP will be engaged to coordinate substance reduction activities with continued support from the GLBTS, recognizing the limited direct implementation capacity of the LaMPs. It is understood that much of the actual implementation would be carried out by the agencies with responsibility to address these substances. A joint review of progress would be undertaken periodically.

Suspend GLBTS Workgroup Activities. Where warranted, refer to another program, and/or participate in other fora. Periodic Reassessment by GLBTS, until Parties determine substance has been virtually eliminated.

In the event that the GLBTS is not able to effect further reductions, or there is no evidence of Basin effects, GLBTS workgroup activities will be suspended. Where warranted, a recommendation will be made to a) refer reduction efforts for the substance to another program, and/or b) represent GLBTS interests in other fora (e.g., Commission for Environmental Cooperation, United Nations Environment Programme). There will be no ongoing workgroup involvement with these substances, though each one will undergo periodic reassessment, approximately every two years, using the *General Framework to Assess Management of GLBTS Level 1 Substances*, until the Parties determine that virtual elimination has been reached.

General Framework to Assess Management of GLBTS Level 1 Substances



APPENDIX B: ENVIRONMENTAL/HEALTH DATA

B.1 SAMPLING AND ANALYTICAL METHODOLOGY FOR ENVIRONMENT CANADA SCREENING LEVEL SURVEYS OF SEDIMENT QUALITY IN CANADIAN TRIBUTARIES TO LAKES ERIE AND ONTARIO

Figure B-1 shows the tributaries sampled in the surveys conducted in the lower Great Lakes for the 2001-2003 period. Surficial (top 1-2 cm) sediments were collected from one or more depositional reaches of each tributary, upstream of its mouth, using either a stainless steel spoon (shallow water depth, low current) or a petite Ponar Grab sampler. The sampling program was based on the Guidelines for Collecting and Processing Samples of Stream Bed Sediment for Analysis of Trace Elements and Organic Contaminants, developed by the United States Geological Survey for the U.S. National Water-Quality Assessment Program (Sheldon and Capel, 1994). Sites represented different in-stream locations (e.g., pools, different depths of water, behind dams). Samples from all sites were composited, sieved and further homogenized and then collected into 250 ml glass jars with Teflon lined screw caps for organochlorine (OC) and polyaromatic hydrocarbon (PAH) analyses. Samples for metal analysis were collected into 125 ml polyethylene jars. Organics were analyzed by Maxxam Analytics Inc. After accelerated solvent extraction, OCs were analyzed by gas chromatography/dual column electron capture (GC/ECD). PAH samples were extracted by sonication, the extracts concentrated, and analyzed by GC/MS. Results are reported on a dry weight basis. Caduceon Environmental Laboratories (Ottawa, ON) performed the metal analysis (including mercury) on freeze-dried samples using *aqua regia* digestion.

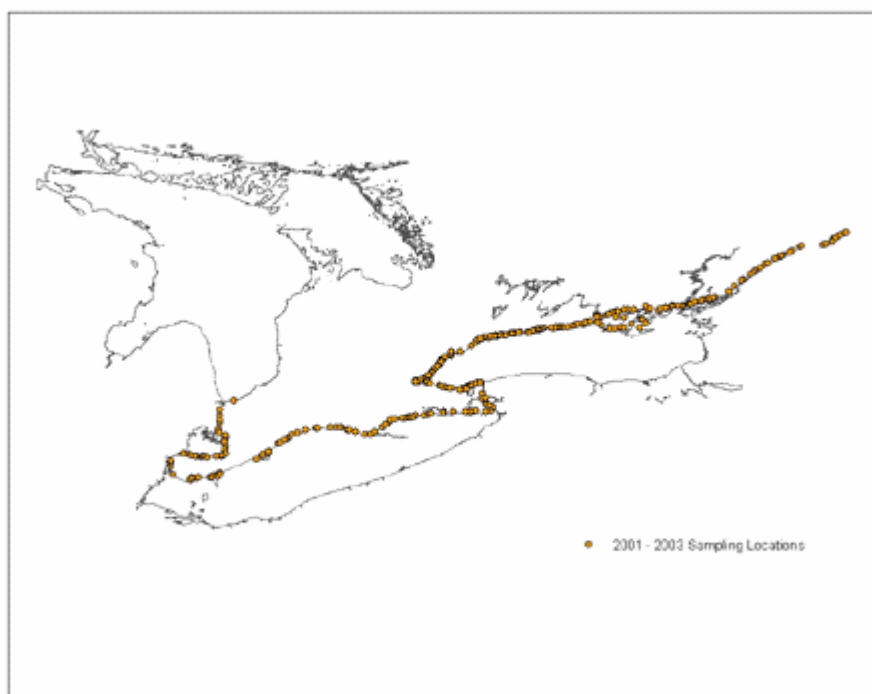


Figure B-1. Sampling Locations for the Lower Great Lakes.

B.2 ST. CLAIR-DETROIT RIVER CORRIDOR – UPSTREAM/DOWNSTREAM WATER QUALITY MONITORING

Objectives and Monitoring Strategy

A whole-water monitoring program for the St. Clair and Detroit Rivers was initiated, in 2001, to assess a wide range of organic and inorganic contaminants. This monitoring effort is a component of Environment Canada's Great Lakes Surveillance and Connecting Channels program and supports Remedial Action Plans (RAPs) for the restoration of beneficial uses of the St. Clair and Detroit Rivers and Lakewide Management Plans (LAMPs) for Lake Erie. The intent is to identify contaminants of concern and to characterize their concentrations with a primary focus on upstream-downstream differences in concentration, compliance with relevant water quality guidelines, values, criteria, and/or objectives, and, where applicable, to provide supporting data to assess the effectiveness of remedial actions and to determine whether improvements in water quality are being achieved.

The monitoring strategy adopted was to select a reference site for each river that was in the main headwater channel, upstream of all riverine inputs. The downstream sampling sites, which are intended to track and be responsive to changing toxic contaminant concentrations, are located below of all major contaminant inputs, in nearshore channels, off the east and west shores of the St. Clair and Detroit Rivers.

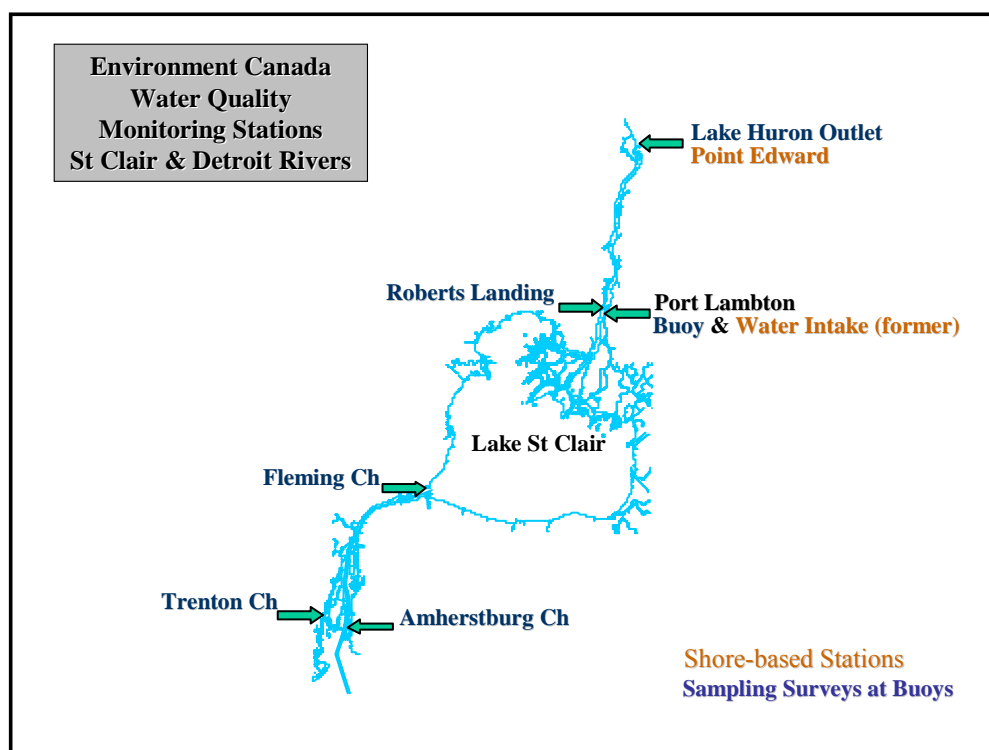


Figure B-2. Water Quality Monitoring Locations in the St. Clair - Detroit River Corridor

In order to realize the goal of providing valid riverine data several the following approaches has been adopted. Clean field techniques are being used and, thus, issues of relating to sample contamination have been effectively mitigated. Collection of large volume samples (150) has provided a capability for ultra low level analyses, for a wide range of contaminants. Therefore, assessing the data against the most sensitive guidelines is being achieved. Back-up samplers are deployed at each site to ensure that samples are being collected. Combined, the data collection objectives are being met.

Methods

The St. Clair – Detroit River Corridor Water Quality Monitoring Program includes extensive quality assurance/control procedures. Large volume samples are collected to achieve appropriate sensitivity. The analytical procedures incorporate clean techniques in combination with the most sensitive and selective instrumentation available. A comprehensive quality assurance program is in place with a large number of surrogate spikes employed to validate the data. The monitoring and analytical procedures are very consistent, and data are generated from one of the most competent labs in North America.

Samples for organic contaminant analyses are collected with submersible samplers that have an internal computer-controlled pump/flow metering system that allows the operator to set the desired sample process rate and total volume to be sampled. Sample water contact with the instruments pump and flow metering systems occurs after processing, and therefore, risks of sample contamination are mitigated. The suspended sediment fraction is collected on stacked filter sets consisting of 3 μm and 0.7 μm glass fibre filters, whereas contaminants associated with the aqueous phase or filtrate are adsorbed onto XAD-2 resin. Sample water is drawn at modest flow rates (100 to 150 $\text{mL}\cdot\text{min}^{-1}$) through the filter sets and then through the column, which contained 85 mL of XAD-2 resin. The resulting bed load flow rate factor is less than 2, and thus, the extraction efficiency is optimized. A total sample volume of 150 L was established to provide sufficient sample for the required analyses and to mitigate the risk analyte breakthrough.

B.3 NIAGARA RIVER UPSTREAM/DOWNSTREAM MONITORING PROGRAM AND THE ST. LAWRENCE RIVER MONITORING PROGRAM

Niagara River Upstream/Downstream Monitoring Program Background

The Niagara River has a significant influence on Lake Ontario. It is responsible for more than 83 percent of the total tributary inflow to Lake Ontario (Eadie and Robertson 1976), 85 percent of the total input water budget, and about 50 percent of all incoming fine-grained sediment (Kemp and Harper 1976). Because of this influence, Environment Canada established a monitoring station in 1975 at the mouth of the Niagara River at Niagara-on-the-Lake to estimate the annual chemical loads and changes/trends in these loads from the river to Lake Ontario. Love Canal, and the publication of numerous reports on the magnitude of the hazardous waste site problem on the U.S. side of the river in the late 1970s, further heightened Environment Canada's concern about the input of chemicals to the river and, subsequently, to Lake Ontario. A second station was established at the head of the Niagara River at Fort Erie in October 1983, to estimate the loads of chemicals to the river from Lake Erie.

This Upstream/Downstream Program, as it became known, was a key component of the Niagara River Long Term Monitoring Plan recommended by the Niagara River Toxics Committee (NRTC 1984). It was formally incorporated into the Niagara River Declaration of Intent (DOI) signed by the Four Parties, Environment Canada, the United States Environmental Protection Agency (Region II), the Ontario Ministry of the Environment, and New York State Department of Environmental Conservation, in February 1987. Thus, what had begun as an Environment Canada initiative became a component of the Niagara River Toxics Management Plan (NRTMP). The overall goal of the NRTMP is to achieve significant reductions of toxic chemical pollutants in the Niagara River.

St. Lawrence River Monitoring Program Background

As part of the commitment made under the Great Lakes Water Quality Agreement, originally signed between Canada and the United States in 1972, Environment Canada began sampling the outlet from Lake Ontario at the Wolfe Island station in the St. Lawrence River in 1976. The data from this program also serves as the upstream comparison for programs conducted further downstream in the river. The St. Lawrence River Monitoring Program mimics the program conducted in the Niagara River with the exception of the sampling frequency. The Niagara River is sampled for organic contaminants on a biweekly schedule vs. every four weeks for the St. Lawrence River.

Sampling & Analytical Methodology

The Niagara River Upstream/Downstream Program measures the concentrations of trace organic contaminants and trace metals in water and suspended solids at the head of the Niagara River at Fort Erie and at the mouth of the River at Niagara-on-the-Lake. Over the eleven-year period 1986/87 – 1996/97, sampling was conducted weekly. Since that time, the sampling frequency has been changed to biweekly. Sampling times at the two stations are offset by approximately 15-18 hours to allow for the travel time of water between the head and mouth of the river.

Large-volume, 24-hour time-integrated dissolved phase and particulate phase water samples for organic contaminants are collected using a submersible pump, intake line, and Westfalia centrifuge assembly connected to a Goulden Large Sample Extractor. This technique is essentially a continuous liquid/liquid extraction. Suspended sediment is collected from the centrifuge, extracted and analyzed according to documented procedures. Since the program analyses two distinct matrixes (dissolved phase and suspended sediment), the concentration in the whole water is determined by calculation.

Sampling procedures and analytical methodologies for the Upstream/Downstream Program have been documented elsewhere (NRSP 2003; NRAP 2000; NRAP 1992; NRSP 1995; Data Interpretation Group 1997; Data Interpretation Group 1999). These protocols, developed and agreed to by the Four Parties, include the requirement for regular audits of Environment Canada field and laboratory operations. The purpose of these audits is to ensure that these protocols are being followed by Environment Canada's field and laboratory staff. Four Party audits were conducted in 1988, 1991, 1993, 1997, and most recently in 2000. In each case, the audit teams concluded that the procedures generally adhered to those described in the sampling and analytical protocol documents and, therefore, should result in generation of data of acceptable quality.

While the St. Lawrence River Program does not undergo any formal audits, it should be noted that the sampling and analytical methodology are identical to the Niagara River program and by extension the data is also of comparable quality.

It is important to note that all analysis over the duration of these programs has been conducted by the same laboratory under the direction of the National Laboratory for Environmental Testing (NLET). NLET is accredited by the Standards Council of Canada (SCC) and is routinely audited by the Canadian Association of Environmental Analytical Laboratories (CAEAL).

B4. Potential Source Contribution Function (PSCF) maps

Modified from Hafner and Hites (2003)

The maps were created using 4-day back trajectories generated by the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model (available on NOAA's website). Each back trajectory is composed of points that represent the hourly location of a single particle along the trajectory's path. IADN samples are 24-hour samples. Back trajectories were generated for times every 6 hours during the sample and for starting altitudes of 10, 100, and 500 m above local ground level. Therefore, a total of twelve trajectories were generated for each IADN air sample.

Effects from temperature (air contaminant concentrations can rise with temperature due to volatilization of contaminants from soil or water) and the trend over time were removed using a regression technique. The natural logarithm of the partial pressure (P , in atm) was fitted to the inverse of the atmospheric temperature (T , in K) measured at the sampling site during the 24-hour sampling event and the time (t , in Julian days relative to January 1, 1990). The unstandardized residuals from this regression were calculated.

Positive residuals correspond to days when the partial pressure was higher than the regression line, and negative residuals correspond to days when the partial pressure was lower than the regression line. To remove ambiguous samples (those with residuals near zero), the standard deviation of the residuals was calculated for each site and used to find the highest and lowest third of the samples, which were retained for analysis by the PSCF model. The trajectory points associated with each sample in the highest third were designated "high hourly points", and all of those in the lowest third were designated as "low hourly points".

The PSCF model was implemented by a program created in Microsoft Visual Basic. This program sorted all of the high and low hourly points onto a 0.5° latitude x 0.5° longitude grid. In each grid cell, the number of high and low hourly points from all of the trajectories was summed, and the PSCF value was calculated by dividing the number of high hourly points in the cell by the total hourly points in the cell. Therefore, the PSCF value is the probability of an air parcel resulting in a high measurement passing through a given $0.5^\circ \times 0.5^\circ$ cell.

Low PSCF values are represented by blue squares, midrange values by white squares, and high PSCF values by pink and red squares. If a given cell did not have at least 25 or more total hourly points, it was not plotted on the source map.

APPENDIX C: ADDITIONAL PROGRAMS THAT MONITOR HCB

APPENDIX C: ADDITIONAL PROGRAMS THAT MONITOR HCB

National Oceanic and Atmospheric Administration's (NOAA) Mussel Watch Project (U.S.)

NOAA's Mussel Watch has been measuring contaminants in mussel and oyster tissues in marine waters around the U.S. coasts since 1986. In 1992, this Mussel Watch Project was expanded to include measurement of contaminants in dreissenid bivalves, zebra and quagga mussels along the U.S. shores of the Great Lakes (Robertson and Lauenstein, 1998). A series of sites, including locations in all of the Great Lakes but Lake Superior, was established for collection of dreissenid mussels. These sites are visited approximately biennially for collection of animals to be analyzed for a suite of over 70 contaminants, including HCB.

U.S. Total Diet Study

The Total Diet Study (TDS), sometimes called the Market Basket Study, is an ongoing program of the U.S. Food and Drug Administration (FDA). Since 1961, the TDS has been used to determine levels of various contaminants and nutrients in foods. Analyses are performed on foods that are prepared as they would be consumed (table-ready), so the final results can be used to provide a realistic measure of the dietary intake of analytes. Analytes include the following Level 1 substances: chlordane, DDE & DDT, dieldrin, HCB, PCBs, toxaphene, and mercury (FDA, 2004). The foods collected in the TDS represent the major components of diet in the U.S. population. A description of the TDS study design, foods, and consumption amounts can be found at <http://www.cfsan.fda.gov/~comm/tds-hist.html>. (Analytical results are available from 1991 to 2001.)